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THEORY OF THE SOLAR SYSTEM.

1.—The earth and planets are supported by the atmosphere or its watery vapour, in the same way as the weight on a safety-valve is supported by the steam in a boiler.

2.—The rotation of the earth is caused by the impacts of the atmosphere upon the earth, *i.e.*, by a constant series of blows from the sun of 2116lbs. upon every square foot. The number of feet passing in a second being, as we know, enormous.

3.—The orbital motion of the earth is caused by the rush of cold air (at night) towards the sun, as the air in a room rushes towards the fireplace. Magnus has shewn by experiment that such a rush of air upon a revolving cylinder compels the cylinder to move in a lateral direction, similar to that in which the earth moves.

4.—The issue of watery vapour of very rare density takes place from the North Pole, where there is little rotation. The atoms of vapour gradually accumulate and form condensations of matter at great distances from the North Pole, when the force with which they were expelled is expended. Thus the earth has formed the moon, and the sun, the planets.

5.—The atoms when condensed are urged downwards to the Equator, and receive there the rotary impacts of the sun's vapour, which compel them to rotate in the same direction as the sun.

6.—The planets may thus be supposed to be at the centre of gravity of great cones extending Northwards, which rest upon the great cone of the sun's vapour. Hence, the motion of the earth may be likened to that of a ball suspended from a string and twisted round, and the earth goes upon its orbit, as one cone rolls round the surface of another. This theory explains satisfactorily, therefore, the observed motion of the earth, which seems to be going forward by twisting itself backwards, in a way quite different to our common notion of the manner in which a sphere or carriage wheel should roll onwards.

7.—The cones are masses of vapour, at its greatest density for the temperature, of sufficient strength and power to sustain the planets in their places, and the distances of the planets accord with the volumes of steam which sustain similar weights,

G. T. CARRUTHERS.

LETTER

TO

THE ASTRONOMER-ROYAL

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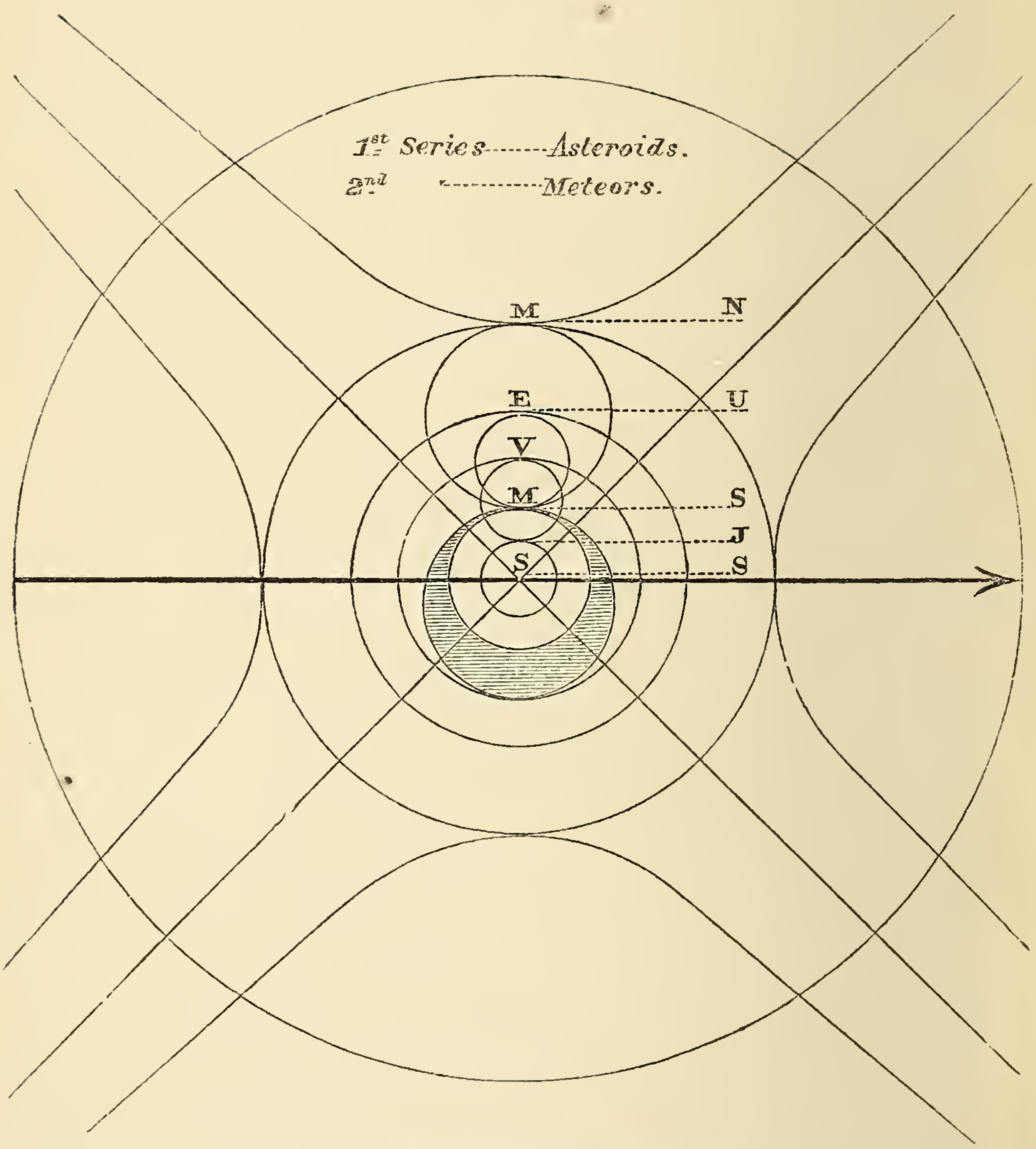

THE SOLAR SYSTEM.

A SERIES OF CONES OR THE PARALLELOGRAM INSCRIBED IN AN HYPERBOLA.

A LETTER

ADDRESSED WITHOUT PERMISSION TO THE

ASTRONOMER-ROYAL

EXPLAINING A

NEW THEORY OF THE SOLAR SYSTEM

AND PLACING NEWTON'S THEORIES ON A PHYSICAL BASIS

BY

G. T. CARRUTHERS, M.A.

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To Sir George Biddell Airy, K.C.B., &c., Astronomer Royal, Royal Observatory, Greenwich.
From the Rev. G. T. Carruthers, Inverness, Scotland.

October 29, 1874.

Sir,—I am so much engaged during my visit to England in advocating the cause of missions in Central India that I cannot pursue scientific researches. I beg, therefore, to send you a few remarks which I have made upon the solar system, which may incline learned men to elaborate the subject.

1. The Earth and other heavenly bodies are sustained in their orbits by steam of such tenuity that 1 lb. is only able to sustain 3 lbs. The steam is at its maximum density for the temperature applied to it and for the pressure of the heavenly bodies which it sustains. Whatever formation, therefore, may be going on within its own volume, so far as other bodies are concerned, its power is the same as a bar of iron in supporting 3 lbs. to every one of its own. It is necessarily produced from the great cold of the polar regions, and 1 lb. occupies about 21,000 cubic feet. It issues from the poles, where there is little rotation, like water from the bottom of a cask.

The result of this issue is the production of a spiral motion of the air towards the poles, and a constant current of wind from the south-west towards the north-east in the northern regions, such as we find to exist on the Earth.

2. When a mass of vapour is under no other force than that of pressing equally in all directions, it will assume a conical form. A square or parallelogram wastes a good deal of its power of pressure against the sides of its resultant, but a

cone's effect is to exercise the greatest power with the least expenditure of matter. The matter on each side of the central force hastens on the course of the diagonals, which the force has taken within the body it is pressing against, so as to bring the force in a line with the point where the blow was struck as soon as possible. It cuts off, in fact, a part of the other's height, and so reduces its opposition. A solid wastes a great deal of velocity, though not of power. It has only a single line of force, but the atoms are congregated together as if they were so many resultant forces, and thus the blow is carried forward slowly; and, if the solid is large, it drives obstacles before it instead of allowing them the choice of an edgeway escape, which would also hurry its own passage. It loses in power of piercing also, for the blow it gives is distributed over a large area instead of being intensified in a minute atom. I need not say that it has its own advantages. A cone of vapour, or rather two cones with bases together, gets the advantage, therefore, in a mass of other vapour; and as its pressure or volume varies according to the cube of its height, there is a thrusting down of other vapour with greatly increasing strength, till most of the vapour arrives at the point where the pressure is equal on all sides—that is, at the centre of gravity of the cone—but in this cone there is room for circular formations, and these have the power of pressing outwardly, each hemisphere with a power of three pounds' to two pounds' weight.

3. I look upon vapour as simply water of rarer density and obeying hydrostatical principles in its own way. In treating of cones of vapour, therefore, I shall assume what I write as regards pressure; but others more skilful than I in such things may suppose each cone to be immersed within another cone of fluid of density equal to the first cone, and with all the properties of water—the inner cone occupying the space of the outer cone within a hair's breadth. In a cone of height 4R and radius of base $R\sqrt{2}$ there is a volume equal to twice a sphere with radius R. The surface of the base of the cone (its minute

outside atoms being looked upon as the surface of a vessel containing vapour) is $2\pi R^2$, and 1R being its centre of gravity, the pressure upon the lower hemisphere (D F E, p. 4) immersed within it, is $2\pi R^3 g\rho$. Now, the surface of the lower hemisphere is $2\pi R^2$, and its pressure outwardly is $g\rho\pi R^3$;[1] but if its density were doubled in any way, as by its pressure from above, its pressure would be that of the base; but as such equilibrium could not exist with matter falling from 4R, final equilibrium would be obtained by a cone being formed behind it (p. 6, fig.), and itself pressing downward till the two cones became commingled in their lower parts in a globe of mixed density so encompassed by the rest of the vapour that the globe's bursting pressure of three times its weight would be prevented, and the whole pressure upon the base of $2\pi R^3 g\rho$ be preserved, when considered from the point of view of either cone—the attraction of gravity not being supposed to act. It should be noticed also that within the sphere, if it were of great expanse, central masses might be placed of great density, so long as the due density of the whole was preserved by attenuating the other vapour and providing it with such pressing power as to sustain the masses when they came against the vapour and condensed it, and with such velocity as to give back as many impacts as it received.

4. The origin of these masses would be due to crystallisation.

Let A B C represent the cone when there is momentary equilibrium. As the parts are not solid, and the minute resultant atoms of the cone have great power, C D E presses towards A B as a cone of wood presses base downwards upon water. A B D E presses down also upon the line D E. Supposing the density of F D E to be that of the Sun, and the other parts to be of an average density of $\frac{1}{21000}$, there would be a very slight entrance of the cone into the trapezium, but this slight pressure produces crystallisation.

Crystallisation can only take place on the Earth in large quantities at the poles, and there is some reason to suppose that all other planets are formed like our own. The heat and light of the Sun are probably due to the intense pressure upon its

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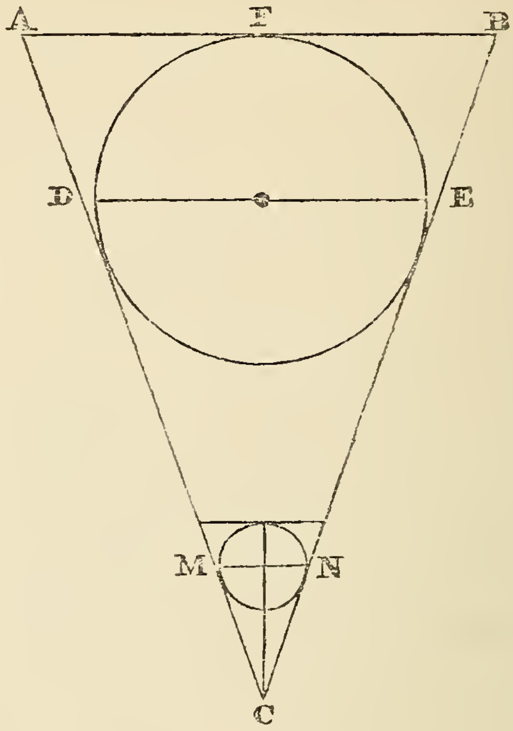
[1] Besant's *Hydromechanics*, p. 26.



equator and the quick motion of its air; and it does not at all follow that this heat may be felt at its own poles, for the heat of our equator is not felt at its poles. The heat may even be the result of pressure and impact of atoms at distances increasing with the distance of a body from the Sun, as shot gets hot in meeting resistance from the air; and even the burning hydrogen that is mentioned may be produced by ignition at some distance from the central nucleus, caused by friction with its oxygen through the velocity of emission, or its effect may be neutralised by distance.

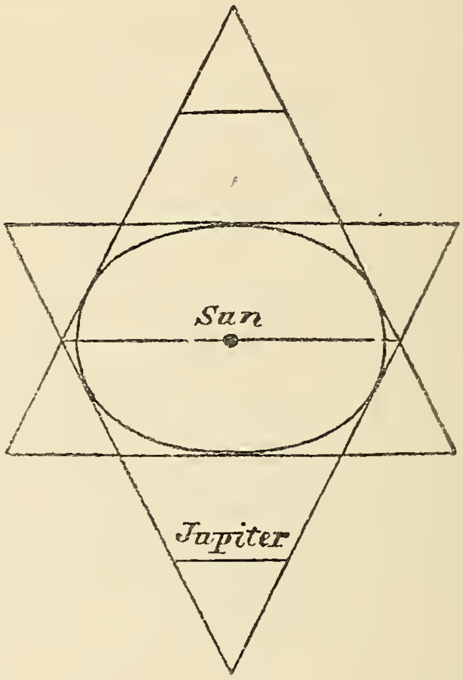
Crystallisation seems generally to take place in a conical form of some kind; and the reason is, I think, that it can only take place when the centre of gravity corresponds with the centre of gravity of the system. Now, in a sphere made up of cones the centres of condensation lie in rims, at regular distances from the circumference and from the centre. The centre of gravity of the cone lies in the centre at $\frac{1}{4}$ from the base. The consequence is that, while the whole cone seeks a common centre, the sphere does not, even though the centre of the sphere is its virtual centre; but when any pressure takes place at the centre of gravity of the cone and the centre of the circle, the sphere overcomes, as it were, its indifference to moving its centres of condensation from the rims about its circumference and centre, and immediately congregates them at the place where the cone is doing so, that being its own centre of gravity also. There is, therefore, a crystallisation when this condensed central pressure is slowly withdrawn by the gradual enlargement of a cone on the other side.

But there is another peculiarity. The cone has places of pressure when immersed in a liquid where the pressure is equal, viz. at the same distance above as below the centre. In each of these places, therefore, there will be a condensation, if at the same time there is a perfect equality of pressure and the sphere and cone have a similar centre. This particular point is arrived at only by degrees. When the first condensation takes place—say, at the centre of gravity of the great cone—the body presses forward into the lighter liquid, and so concentrates at the centre of the small cones a denser vapour, and one by one each centre crystallises and presses onwards to find rest. In the figure the great centres of pressure are at D E and the base of M N. D E at once crystallises, and the others do so (M N almost immediately) as the cone mounts higher into the gradually decreasing denser liquid.

If the above condensations be those of the Sun and Jupiter, each being formed at one radius from their respective ends of the cone, the Sun will begin to press the other cone at its back, and by these fresh and constant condensations will become the centre of the two cones, Jupiter contenting itself with going round from one centre to the other.

It is probable, having been thus formed, that the length of the diameters of these two bodies will bear some proportion to the height of their cones, the cubes of each being proportioned to their volumes. The proportion will, however, be with the radius of the Sun, as Jupiter's diameter is made up of double condensations.

The Sun is situated at a distance of 3R (not 4R) from its apices; $\frac{1}{27}$ of its diameter represents, therefore, R of the inscribed circle of the cone whose height is 1, and the base of that cone is Jupiter's diameter—$\frac{1}{27}$ of $882000 = 32666$ miles—and Jupiter's diameter $= 2\sqrt{2}R$ of the cone whose height is 1. Therefore, $32666 \times 2\sqrt{2} = 91369$ gives Jupiter's diameter, which is given in books as being 90,734 miles, so that the difference is not great between that and the calculated diameter.



I know no better illustration of the formation of such a cone as I have been speaking of, and the gradual expulsion of matter from its base, than that represented by Herschel's Section of the Milky Way, if indeed the Milky Way is not the great cone itself. The Zodiacal Light is its shadow, perhaps.

5. I think a clue to the mystery of the distances and weights of the planets may be found by considering that the great object of the Sun, if I may so speak, is to be supported. Every foot of his diameter is, therefore, duly apportioned out to one or other of the planets, and the attempt is made to find the value of π, or to divide the diameter and circle into similar portions.

The diameter (with 27 as its basis) is divided into 8 parts or great divisions, and its sphere is cut into 4 parts by Jupiter. The sphere of Jupiter (or its orbit) is, then, subdivided and supported by Saturn, and so on with the rest, each of these divisions telling again upon the Sun and decreasing the size of the great divisions by Jupiter. The support is given by cones of vapour, and the Sun is virtually placed at the centre of gravity of each. There is, therefore, always $\frac{3}{4}$ of each cone above the diameter of the Sun, or of some planet acting as its centre of gravity. This $\frac{3}{4}$ has a portion of its apex condensed into a planet, and thus the necessary equilateral triangle is obtained, with the revolving perpendicular of which the divisions are truly marked out, and support given to each portion of the Sun by the planet as it sweeps round the heavens and obtains at the same time support for itself. The perpendicular above the centre of gravity is as 7 to 4 of the radius (Hutton's Tract, xv.) in such cases, and the figure marking out each planet's distance will be that of two circles cutting each other with a planet at the point of intersection. Two circles touching one another represent the issue of vapour from each pole, and a central circle will be the orbit of the planet, but it must be of a larger size; but I shall refer to this again. The following show the distances without rectification for condensations or expansions.

Mars is at a distance of 1·52 of the Earth's radius from the Sun, which acts as its base, and $\frac{3}{4}$ of its cone, with the other fourth below the centre of gravity, rests upon another planet's orbit—which will be that of Mercury. $1{\cdot}14 + {\cdot}38 = 1{\cdot}52$.

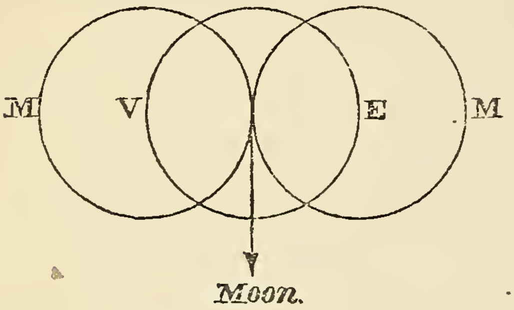
Earth, with Mercury's circle as its base on the other side of the Sun, $= 1{\cdot}387 = \frac{4}{4}$, but $1{\cdot}038 = \frac{3}{4}$ instead of $1 = \frac{3}{4}$. Neptune, with Saturn as base, $30 + 9{\cdot}5 = 39{\cdot}5$ instead of 40.

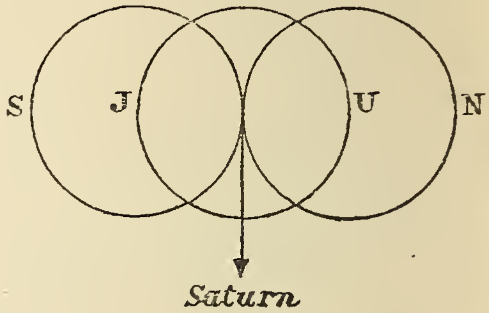
Uranus, with Jupiter as base, $19{\cdot}18 + 5{\cdot}2 = 24{\cdot}38$ instead of 25·6. In the above cases the Sun is the centre of gravity of the cone.

Saturn makes Jupiter its centre of gravity $9{\cdot}5 + 5{\cdot}2 = 14{\cdot}7 = \frac{3}{4}$

of 19·5, or Jupiter and Saturn act as two equilateral triangles, of which each is an apex. I am not able to see the connection of Venus, unless it be with an inner planet; or, perhaps, Earth and Venus stand to one another as Saturn and Jupiter.

Supposing the inner series of planets to have been once in the same state as the outer series, the Moon occupying the place of condensation that Saturn does, two sets of rings might show their relationship and formation.





6. Before proceeding to the next point I should mention that in a perfectly mobile liquid, such as vapour, the resultant of forces of pressure depends, I think, entirely on the height of the descent and the weight of the body descending, and is the mean between two opposing areas or volumes, as the case may be. The resultant force is a perfect diagonal of the height with the weight at its apex; half of the weight goes on one side and half on the other, and if the body has sensible thickness each layer keeps its place. Whatever promiscuous pressure there may be beyond this goes for nothing, just as we find that a cube and pyramid of water have the same effective pressure, though one is much less than the other in capacity.

In the cones that we have been considering, where there is equality of pressure, condensation of a portion occurs, because the resultant forces, having done their work, remain exactly where they were when the force of propulsion ended, which was at only half their due distance, because of the opposition of the other forces. We may guess, therefore, somewhat at the power of condensation by a formula.

The pressures were $2\pi R^3 g\rho$ upon each base and at right angles to it through the crossing of forces (fig., p. 6). Taking resultants in only two directions, we have $2\sqrt{2}\pi R^3$. This represents the weight, or proportion of the whole weight, caught at the moment when the forces ended, or their average power of cubical expansion each moment. But the original pressure of the cone was the base multiplied by the height which was 4R. That is $4R \times \pi(R\sqrt{2})^2 g\rho = 8\pi R^3 g\rho$; therefore

$$\frac{2\sqrt{2}\pi R^3 g\rho}{8\pi R^3 g\rho} = \frac{\sqrt{2}}{4}.$$

This $\frac{\sqrt{2}}{4}$ is the portion of weight left condensed by the intermixture of the cones, condensed in volume from 64 to 27. Therefore $\frac{\sqrt{2}}{4}$ of $\frac{1}{27}$ is an approximation to the condensation which takes place in any volume of matter undergoing crystallisation. The cones, one on each side of the Sun, from which Jupiter was formed were $\frac{2}{27}$ that of the Sun; its mass therefore will be $\frac{\sqrt{2}}{4} \times \frac{1}{27} \times \frac{2}{27} = \frac{1}{1031}$ that of the Sun.

7. If the Earth is of density equal to 5·3 times the density of water, its volume in the vaporous state would be

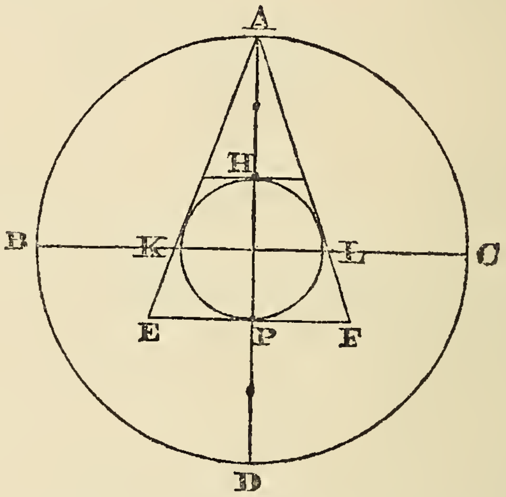
$$\frac{4\pi R^3}{3} \times 333 \text{ lbs.} \times 21000 \text{ feet},$$

with a diameter equal to 382R, or a radius about $\frac{1}{64}$ the distance between the Sun and the Earth.

Probably the Moon is supported by the same forces which support the Earth.

Let the circle A B C D represent a sphere of vapour of the Earth's weight, with the Earth in the centre sending forth vapour from its poles. Divide the radius of the circle into three parts, and with $\frac{R}{3}$ describe a circle representing a sphere containing $\frac{1}{27}$ of the Earth's weight. Upon this smaller circle describe a cone of double the volume of the circle E H F, and with radius at base $=\frac{R}{3}\sqrt{2}$. The little cone A H is, therefore, $\frac{1}{4}$ of the weight of circle E H F, and the rest of the cone is $\frac{3}{4}$ of circle weight.

Vapour, derived from the mixture of the salt and ice of the poles, will continue to issue from the Earth with the force of steam of low density, and will thrust itself into space till the weight above it is equal to the force of issue. After that condensation will occur until equilibrium is obtained. The little cone A H presses downwards with a force represented by the diagonal A P, or with a weight $\sqrt{(\frac{1}{8})^2+(\frac{1}{8})^2}=\frac{\sqrt{2}}{8}$ of $\frac{1}{27}$ of the Earth's weight.



The hemisphere K L presses upwards with a force represented by half the diagonal A P, or, as its weight is half the circle, $\sqrt{(\frac{1}{4})^2+(\frac{1}{4})^2}=\frac{2\sqrt{2}}{8}$ of $\frac{1}{27}$ of the Earth's weight.

The momentum of both forces is the same, as one falls from double the distance of the other $=\frac{2\sqrt{2}}{8}$ of $\frac{1}{27}$, and there is equilibrium; but as the issue of vapour continues condensation sets in, and $\frac{\sqrt{2}}{4}$ of $\frac{1}{27}=\frac{1}{77}$, or about the Moon's weight, sinks down as a mass.

8. The position it assumes is a point about $\frac{R}{3}$ in the radius

of large circle; for while the vapour is able, thrusting upwards, to push on as far as $\frac{1}{2}$ the diagonal A P, it is able to carry a dead weight only half the distance, or to about 64 radii of the Earth distant.

9. It is plain that the effect of the hemisphere of vapour, thrusting upwards, can be obtained by a resultant force along the radius equal to $\frac{1}{2}$ A P. A frustum of a cone from Earth to Moon would accomplish it; but as a frustum with bases 1 and $\frac{1}{4}$ has not quite the effect of a column or cylinder, in consequence of the crossing of its forces, the Moon's distance would be decreased to 60 radii, probably, instead of being at 64 (another explanation of the same cause will be gathered from what will be said[1] about the reduction of volume of steam at 212° from 27 to 26·36, which accounts also for a difference in the weight given above of the Moon). The weight of such a frustum of vapour of density 21,000 feet to a lb. would be 112·7 trillions of lbs.

The frustum being nearly a cylinder, its effect can be produced by a cone[2] of same height and base and density; and this, again, can be replaced by a cone of same form but greater velocity of its atoms. But the vapour issuing from the Earth has an internal power of supporting 3 lbs. to one; therefore $\frac{1}{3}$ of the weight of the cone would be sufficient. There is a further consideration. This vapour sustains 3 lbs. for one, notwithstanding the influence of gravity; but in this case gravity acts as an element in its favour, impelling the Moon and Earth asunder, so far as the impacts of each little atom are concerned. And as all the cone's effects are arrived at through resultant forces it seems probable that $\frac{\sqrt{2}}{3}$ is the additional power of steam; by that amount, therefore, the weight of the cone of atmosphere may be reduced. Here is a summary:—

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[1] I regret that pressure of engagements prevents my writing upon steam as I had intended to do.

[2] A paraboloid thus acting—and it is the form a rotating liquid would take under pressure—would account for the absence of atmosphere in the Moon.

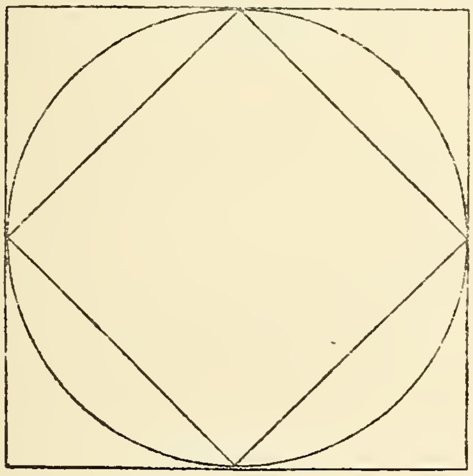
112·7 trillion lbs. = frustum exerting pressure = to nearly twice its height
$\div 3 = 37\cdot57$ „ = cone of similar density exerting equal pressure
$\div 3 = 12\cdot52$ „ = cone of $\frac{1}{3}$ weight with force of 1 lb. sustaining 3 lbs.
$\times \frac{\sqrt{2}}{3} = 5\cdot9$ „ = $\Big\{$ cone with allowance made for height of fall of atoms.

But 5·9 trillions of lbs. is the weight of atmosphere of half the globe; so that, if the above conclusions are right, it does not seem improbable that the Earth's atmosphere performs one more important duty than those already assigned to it by general assent.

10. It might be of advantage to one who has leisure to carry out further this conception of the working of cones and diagonal forces. A system of cones with their bases placed upon the circumferences and inner rings of a circle, with vertices pointing inward and made as small as you please, might be made to bear the weight of a globe; while a very large sphere, with conical formations throughout it, would not only bear its own weight, but would have power to sustain large internal masses of condensed material such as we perceive existing in the solar system.

The bottom part of a cone equal in volume to $\frac{3}{4}$ of the inner sphere, with a resultant pressure of $\frac{3}{8}$ and the additional power of vapour, would sustain $\frac{9}{8}$ spheres, and the increasing of such cones would have a great effect; 8 cones would support a sphere, 64 of them 8 spheres, or a single sphere with several floating within it. The best way to study the system of the Universe is, I think, to study the effects of pressure. I have drawn the well-known figure to show the way in which pressure and volume seem to me to be connected. If you double the pressure you halve the volume in things of little density. That is, you can always resolve the pressure of forces into a single force, acting at its centre, of double the power, for power or motion has no weight; but when you reduce the volume you have to carry weight, and this introduces a second force at right angles to the power, and the resultant will be $\sqrt{8}P$; but the new volume will only occupy half the parallelogram, for only pure force can go the whole length of a diagonal. The parallelogram will be smaller also, for the original force of 2P was able to carry its rare atoms to the length it did; but when it has to carry them in a denser form it can only do so to half the extent. The plane area will be, therefore, $\frac{\sqrt{8}}{4} = \cdot 707$ if 1 lb. and 1 foot square were the units; but if it is a cubic foot then half the volume will be the result.

In the figure the sides of the outer square represent the pressures, and the inner square's sides the volume. Now, by increasing the volume and decreasing the strength of the individual impacts, and increasing their number, we shall arrive at last at a circle representing as near an approach as possible to unity when the pressure and volume are divided one by the other, and thus we shall arrive at some proper notion of that tangential force which issues from the Sun, and of the exact condensations which arise from it in the matter around us.



11. Returning to our subject of the Moon, its condensed mass remains in its position of equilibrium until the Earth moves slightly in its course. The impacts of the ascending vapour are then received at a different angle, and a motion of rotation is produced by the couple of ascending and descending

forces. When thus or otherwise a tendency to rotation is given, the Moon begins to receive distinct blows from the Earth's atmosphere, exceedingly minute of course, but constant, and acting along the tangent of the circle. In the rotation of the Earth through the Sun's influence each foot of the Earth receives a pressure of 2,116 lbs. on the square foot; this force is really a series of blows equal in effect from the time of the Sun's passing upon and over the foot of space to 2,116 lbs. square on the square foot. If one remembers how many feet pass over in a second, viz. $\frac{4\pi R^2}{24 \times 60 \times 60}$ (though allowance must be made for the number that pass off each second and the number that remain under constant influence for hours), one can conceive how enormous is the force thus generated by these little strokes of the atmosphere in a day. The units of work in foot-pounds stored up in the mass of the Earth is about R^4, but the strokes of the atmosphere would bring this unwieldy mass to move in almost the time that the full effect of the strokes could be felt at the other side of the globe, if they took as long to move through the Earth as through air.

12. It is said that the law of attraction does not allow the presence of air beyond 4 or 5 radii of the Earth; but in such case we should have to contend against the theory of light which claims distinctly for that element that it is caused either by emission of bodies from the Sun or undulations of ether (but as it has lately been shown that undulations have a forward motion, both must exist, though light may be due only to the undulations). In either case there must be a medium, which I believe to be the vapour I am speaking of, and it can exist, though in an attenuated form, in many regions, of much less density than $\frac{1}{21000}$, notwithstanding gravity, simply because it is the cause of gravity and supports the Earth, and not the Earth it.

The conical formations from the Sun may, however, be condensed through the greater part of the distance to the Earth by constant impacts upon the Earth's surface, and we may thus explain the fact that there is only a pressure of 2,116 lbs. on the square foot. For supposing the Earth to be encircled with cones of the height of 2R, the pressure upon the bases or surface of the Earth will be $4\pi R^2 \times 2R = 8\pi R^3$ feet of the density of 21,000 to a lb., and $\dfrac{\dfrac{8\pi R^3}{21000}}{\dfrac{4\pi R^2}{1}} = \dfrac{2R}{21000} = 2000$ lbs. This 2R may, however, be only $\frac{2}{64}$ part of the whole cone; but omitting the consideration of the Earth's condensation, and supposing that there is simply an intermingling of cones of 4R in height, the pressure upon the surface being 2R, the pressure upon the base or lower part of the globe will be $\pi(R\sqrt{2})^2 \times 4R$, and upon the other base or the inner surface of the uppermost hemisphere will be the same, or the pressure will be of the two $\dfrac{8\pi R^3}{21000}$; that is, the external and internal pressures will be equal.

13. The pressure of this 2,116 lbs. upon the air on the Earth's surface is of course not unresisted, but at first the resistance is a mere nothing, and the atoms are simply driven forward upon one another; but as the volume of a cone increases according to the cube of its height, and the base slowly, the time comes when full resistance is made; equilibrium is obtained and condensation sets in. This may be represented, since a cone contains $\dfrac{8\pi R^3}{3}$, without taking large figures by the weights ultimately arrived at, viz. 2,116 lbs. in one direction and half that weight in the other, or 1,058 lbs. $2116 \times \dfrac{8}{3} \times \dfrac{\sqrt{2}}{4} = 1995 =$ the power of condensation, 1058×64 (the cube of cone's height 4 units) $= 67721$ volumes, $\frac{67721}{1995} = 33{\cdot}9 =$ amount of volume condensed, $\frac{2116}{33{\cdot}9} = 62{\cdot}35$ lbs. weight of one volume condensed.

Still more roughly we may divide 2,116 by the $\frac{2}{64}$ volumes condensed, $\frac{2116}{32} = 66$ lbs. The weight of water, the body condensed, is 62·4, and of sea-water 64·05. By referring to page 26 it will be seen that the pressure is rationally expressed by the formula $\frac{2\pi R^2 \times 2116.4}{48\pi R^2 \times \sqrt{2}} = 62{\cdot}352$ lbs.

But this marvellous power which a cone has of increasing its pressure with a small increase of height does not end with the formation of water. If we take the base sufficiently long and wide we shall arrive at a condensation even of water itself, or rather which will compel water to give up the matter which it holds in solution, and a volume of 333 lbs. will be given, or a foot of earth. If the 'imaginative faculty' is allowed play I can imagine greater things. The density of air is $\frac{807}{10000}$ of a lb., and this is 1,694 times the weight of a foot of vapour of $\frac{1}{21000}$ of a lb. Now, a foot of water expands into 1,696 volumes of steam, and that volume may in turn be condensed into a foot of water. Is it not possible that all the elements may have a common origin, and that oxygen is but the outcome of the immense pressure caused by the weight of vapour above the Earth? As I have looked at the stars I have often wondered what may be the great chemical work that each is performing; some have only hydrogen, others hydrogen and nitrogen, and so on; the Sun would perhaps be the hydrogenous body. Mercury would be stifled with nitrogen (weight 4·6). Venus is bright with the incandescence of carbon, and our Earth is the great consumer of oxygen and the stealer of atoms, even the Moon itself, from surrounding space, being so near the centre of gravity of these inner planets.

14. The impacts given to the Moon by the Earth's atmosphere are equal to 2,116 lbs. square, multiplied by the number of feet passed per second. A cubic foot of vapour extending to the Moon would weigh $\frac{21000000 \times 64}{21000} = 64000$ lbs. But the weight of vapour is only 2,116 lbs.; and therefore, even if 64,000 lbs. of vapour were the pillar of support between the masses, the 2,116 lbs. must travel 32 times faster to give the same impetus.

Now, a cubic foot of earth on the equator travels $\frac{2\pi R}{24 \times 60 \times 60}$ $= 1,453$ feet per second, and it is very probable that this is due to a resultant pressure of two forces $= \sqrt{2} \times 32^2$, each of them equal to 32^2 feet per second, viz. a force derived from the impact of the atmosphere $= 1,453 \times (2,116)^3$ per second (or thereabouts, for it is difficult to determine. See p. 14) per foot, and the other from a cause hereafter to be described under the remarks upon translation. Since then $\frac{2116^3 \times 1453}{2R \times 333 + 2116} = 32^2$, and $(2,116)^2$ lbs. gives an impetus of 32^2 feet to about 1 lb. of earth per second, 2,116 lbs. would only give a momentum of 32 feet per second. But the force of gravity gives 32 feet velocity to 1 lb. in a second, and therefore it does not seem improbable that the force of gravity is really the impact derived from the pressure of the atmosphere. The vapour gives that momentum, by itself travelling so fast that each foot would strike another foot with a momentum of 32^3 feet per second at one impact.

This is the part of my letter which requires the most careful treatment, but also too long a time for me to thoroughly prepare it and work out the proper satisfactory results. I trust, therefore, that some one more fit in every way and with more leisure will hereafter so treat the subject as to induce its adoption by scientific men.

15. Magnus, in his experiments upon projectiles,[1] has shown that when a cylinder is rotating, and a strong breeze is made to blow upon it, a lateral motion is given to the cylinder in the direction where the atmospheric pressure is weakest; that is, towards the side where the wind of rotation corresponds with the direction of the wind of the fan.

The Earth (or its atoms), when it was thrust out from the Sun, both condensed its own vapour and thrust backward a long column of other vapour. Immediately the impulse ceased (these impulses are ever taking place among the atoms—I speak of the Earth, for convenience) the pressed air began to thrust back the solid nucleus in its effort to expand back to its former volume, and so blew, as it were, upon the Earth in a direction contrary to its rotating wind, and produced a lateral motion shown in the figure as proceeding to the top of the page.

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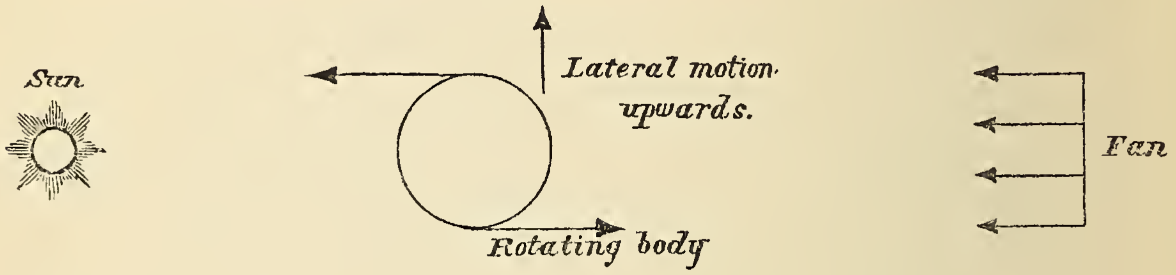
[1] Taylor's Scientific Memoirs.

Directly this lateral motion takes place the Earth is removed from the Sun's influence, and there is at once produced a falling to the Sun—an expanding push, not an attraction—and the result is the Earth takes an orbital motion, or the diagonal between the two forces.



16. The condensations of vapour take place above the polar regions, but as the body descends to the Sun's equator it meets the rotatory winds of that luminary. These brush away and appropriate the condensed air carried in front of the body, and give it a horizontal side blow. This takes the planet out of its former course to go around the equator. The impetus, however, which it had previously received carries it still downward below the equator, until it again accumulates in front of it air condensed sufficiently to stop its progress. This air again pushes it backwards till once more it gains the equator, and the same backward and forward motion is repeated.

It is, I think, in some such way as this that we may account for the ecliptic cutting the equator. The explanation may be put in another way. There is a general pressure northwards of the Sun and planets; when the Earth arrives on the equator and is stopped from going further south, it is then pressed from behind like the Sun is, but at a different angle towards the Sun's north.[1]

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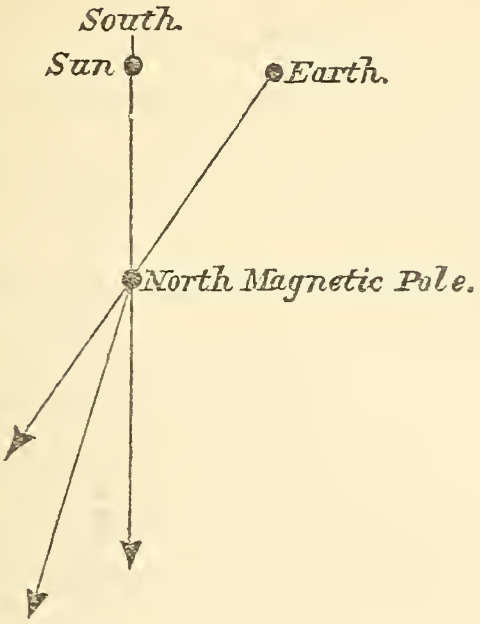
[1] This pressure from behind is, perhaps, caused by the impacts of condensation, which may be received at the south pole and driven out at the equator instead of

The Sun's rotation overcomes that of the other, and a rotatory couple is produced, carrying the planet round the Sun, and both going corkscrew-like towards the north with redoubled force against the next falling objects, whether atoms or planets, that may be above the equator.



The motion of an atom downwards changes in degree and character at every mile, and its rotatory movements also change. When it arrives well off the Sun's body there is only pressure upwards and downwards; the thrust, therefore, of the lateral motion will be such as to carry the body at an angle of 45° directly away from the Sun, till it at last is brought to a standstill by other pressures, and gradually returns to give an impact to the Sun, and then begins whirling round again till it arrives once more at the north pole. The rotation of an atom ascending spirally, then rotating perpendicularly to the Sun's rotation, then descending to the equator, then flying off at a tangent till it is twisted back again, reminds one of the action of a gyroscope. The planets do not themselves go north, but they receive all their effects and act towards one another as if

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being received on the equator itself, so that the action is that of a Barker's mill with height equal to radius of trunk—a perfect machine.

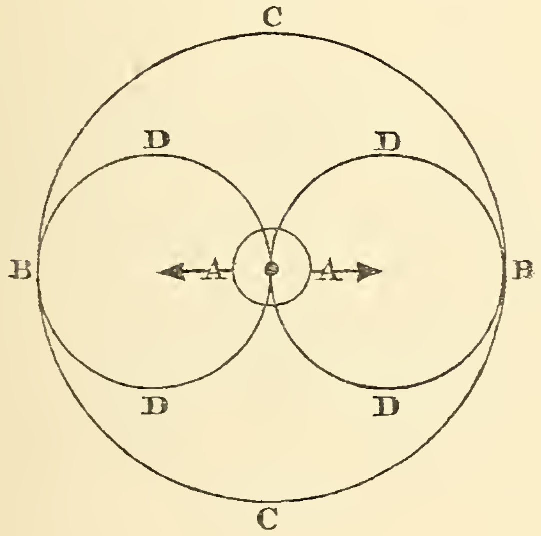
I merely suggest this; it is enough for my purpose to suppose the pressure from behind to arise from the fact that vapour, given off from the north, has made the Earth lighter, so that it was driven northwards.

they did. So, also, the pressures upon one another of the planets and Sun upon the equator is simply another mode of expressing the pressure of atoms driven off and returning to the Sun after their journey away from the equator. The atoms of vapour which ascend and descend from the north (or south, according to the time of year) are the great moving force of the universe. The Earth and other planets are mere resting-places of the vapour, which, having given its blow and deposited its little atom of extraneous matter enveloped within its vesicles and brought from some other planet, goes off again in its journey.

There is a constant tendency, however, in the planets to go northwards, which is prevented by the Sun itself doing so just as the Earth goes north in its course around the sun, with reference to the motion of the Moon, when it cuts the equator. The pressures which the Sun receives are easily felt; for it is not his huge body that has to be hurled onwards by some tremendous original impact—which I never could believe God gave it with his hand, and there is no big enough cannon for it to have been exploded from in our parts of the universe—but every movement is guided by the condensation of a little air in front of it, or the giving off of a little vapour from its poles. I think we should notice, also, that in the system advocated by me several great mechanical principles are introduced: the lever and the balance and the screw are constantly employed; and I think there is something very fine in the way in which the Sun, when it receives a pressure on one side or the other, does not move itself, but thrusts out from the great shaft of planets the one that balances the others best, and can exert most power at the distance. What planet could resist the united efforts of Jupiter and Sun when, screw-like, they go rushing against it, lagging on the borders of the equator? Or, again, what more refined spring-balance can there be than a column of steam which yields to every breath and weighs matter to the very grain?

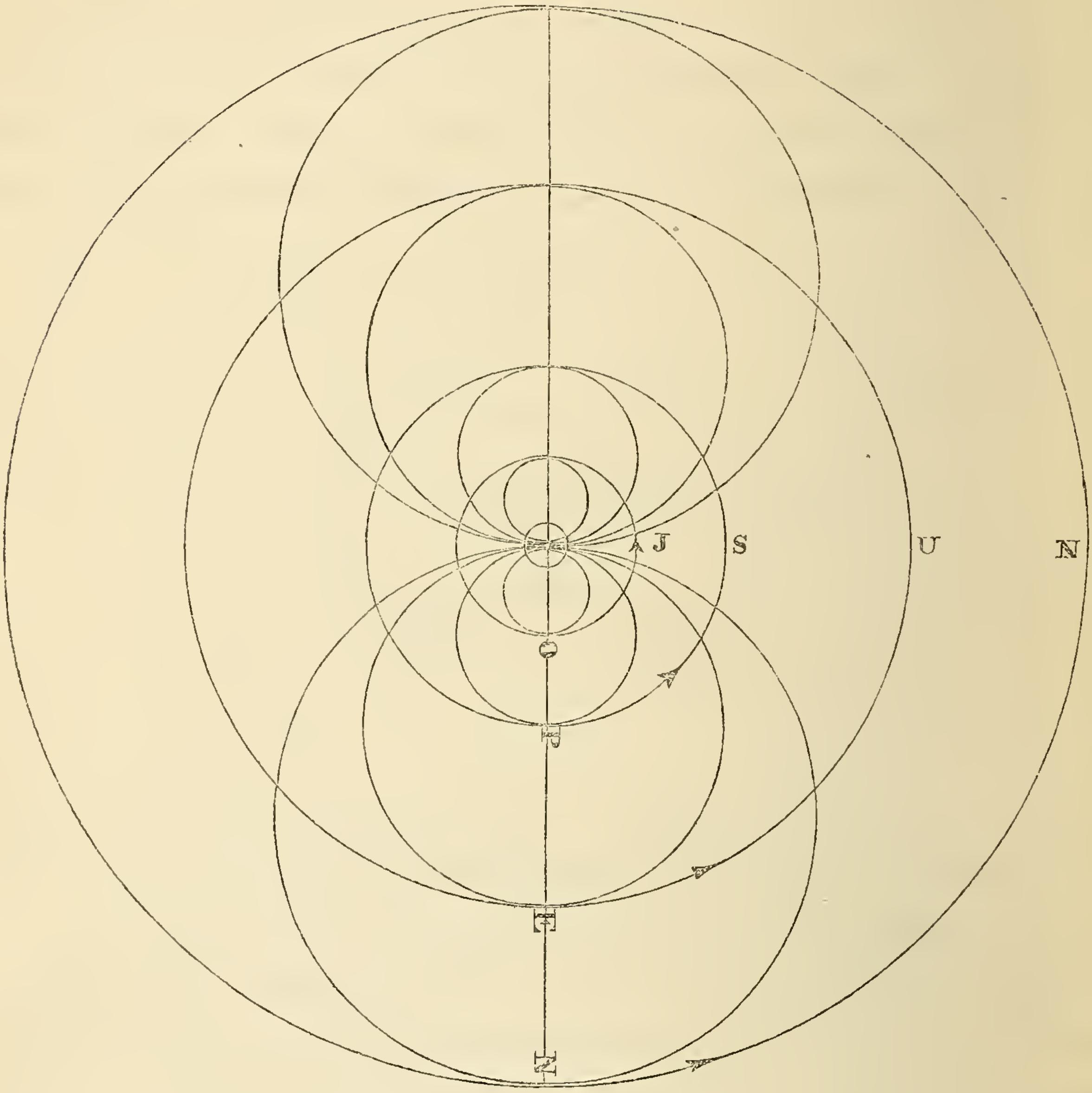
17. There are many double stars in the universe where one star is perceived to be going round the other. I think Jupiter

and the Sun make the double star of our system (since Venus and Earth have had their career stopped by the Sun in great measure), and that each is going round its centre of gravity, or going through space, as a bar of iron with two balls of very different size at its ends would do when hurled into the air. Jupiter's bulk is three times that of Saturn, and it has a restraining power, therefore, upon the orbit of that planet, preventing its bursting out of its proper bounds. I draw here a few rings to show in what way I think the planets have been formed. The Sun is the great originator ; but the planets each help a little, and so make irregularities in the distances. A A represents the Sun sending forth vapour till the force of vapour pressing upon the little circles A B D produces condensation. The circle B C B C represents the orbit of the planet under the action of the force upwards, and the lateral motion produced by pressure of wind from behind. Jupiter, having been thus formed, becomes the central circle cutting Saturn's rings (fig. p. 22), and so on with the other circles. But it must be noticed that the Sun's circle's radius is only divided into three equal parts by Saturn, Uranus, and Neptune. Jupiter and the Sun are as one, having a common centre of gravity, and this centre of gravity is pushed nearer the planets—that is, out from the Sun's centre —as each circle is formed ; but I have contented myself with making the figures perfectly regular ; for it would be impossible, except in a large figure, to make any show of irregularities.

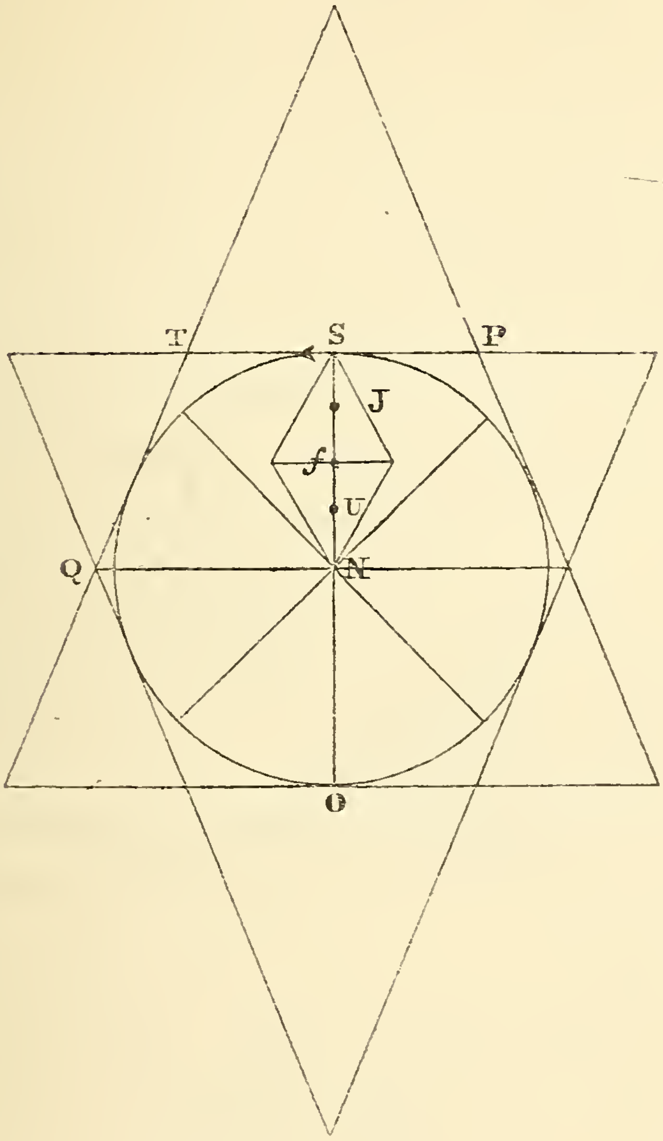


The figure requires, I think, no further explanation. O P E N show the circles springing from the Sun's side, and J S U N show the final orbits.

18. The Sun is being gradually pressed or is pressing on to a centre that is towards the north, but returns again to the south, making a little tour round its centre of gravity, with reference to its own Sun. And so, it may be said that the Sun goes round the Earth; for when Jupiter in the figure falls towards P, the Sun also moves forward towards O in its own circle S Q O. Let S represent the Sun going upon its course represented by the straight line and arrow, P S T, cutting the cone above it, O is the north. It is manifest that as the planets are being formed the Sun gets lighter and lighter, and so is being gradually pressed towards the centre, and will finally gain it. This centre



at N is the place of meeting of forces, and the Sun uses it as an anvil, pressing out the planets and gradually forging a central



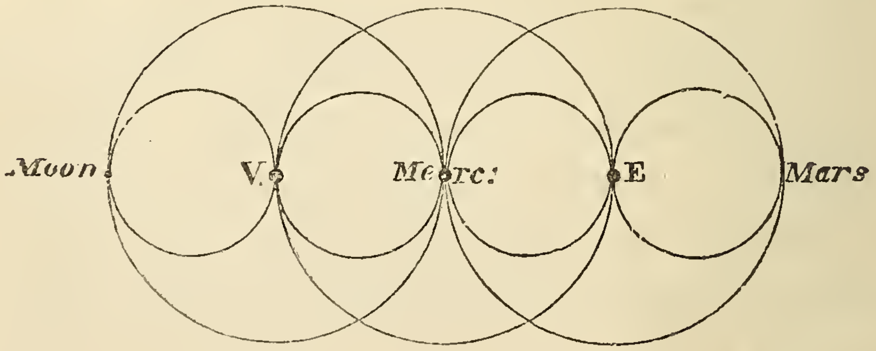
piece of globe at Saturn, the least dense of the planets. The planets on the Sun's equator are only apparently out of their places, for they are receiving there, as I have already said, all the effects of the atoms which descend upon them, and are being urged in their course by unceasing impact. They are also doing an important work with reference to the Sun, for they by their united weights are pressing out from its sides the material which it is giving forth, and are the cause of its heat and light.

The greatest weights or masses of the planets are upon the equator nearly; but the denser are naturally urged nearer the Sun—that is, they have sunk in the liquid to that extent. Mercury is by far the heaviest, for its size, of all the planets.

The planets are really floating in the air, and they fulfil the necessary conditions of floating equilibrium, because at the spots where they are the pressure of the surrounding atmosphere is such that it is equal to their weight. If notice has been taken of my remarks on crystallisation, I need not again say that at the great centres of gravity there is a pressure from all the other parts of the system so great as to compel crystallisation, and the weight is in due proportion to the volume. The masses are simply condensed fluid floating in their proper place. The fluid pressures upon the planets, Sun included, are the pressures upon the whole surface multiplied by the height of the liquid; thus from the Moon the weight upon ½ the Earth is $2\pi R^2 \times 60\,R \times \frac{1}{21000} = 2\pi R^2 \times 60{,}000$ lbs.—this is the constant pressure that I have before alluded to of 2,116 lbs. × 32 feet a second, and it is by constantly recurring impacts from this force that equilibrium is kept up.

19. There is a curious agreement in the order of the densities, if we suppose the Moon to have been originally in the condition of Saturn.

Mercury	1·14	Sun	·25
Venus	·84	Jupiter	·24
Moon	·556	Saturn	·11
Earth	1·000	Uranus	·20
Mars	·72	Neptune	·15

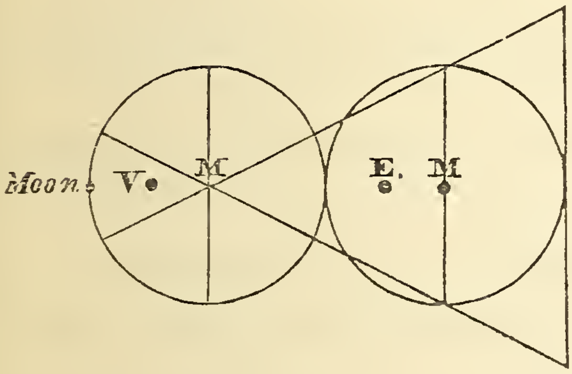


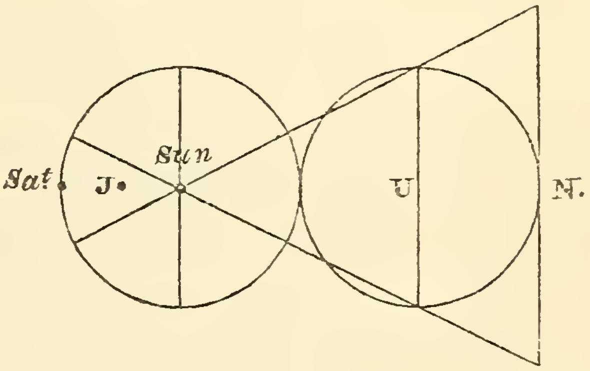
I first draw a figure with Mercury in the centre of its series as the densest of the five, where it receives the combined pressure of the double stars, Venus and Earth; the Moon and

Mars, being formed outside, receive only half the pressure that Mercury does.

When Mercury became consolidated it began to move into the lighter vapour on the Moon's side; the Moon—or rather its liquid, for it was not yet formed as at present—ascended, therefore, and took Mercury's place. The Earth then gradually came down into the Moon's sphere, and, I suppose, by doing so produced solidification of the Moon, the Moon attempting to go on to Mars; but these motions still go on around the Sun.

I draw two figures showing the transition state of Mercury and the present state of the Sun system. There are two cones formed on each side of the Sun's base, getting lighter as they recede. The Sun presses towards Saturn's sphere, and Saturn and Jupiter move round him in a kind of harmonic motion.





The planets thus may be said to be floating about or constantly falling into lighter places, but still are being driven north as well; and the little planets are above the Sun's equator, perhaps, instead of being on it, for this reason as well as that already given.

20. We proceed now to make a few remarks concerning the mass of the Earth. We have already suggested that it is not necessary to suppose that the cones of vapour are continuous, though they act as if they were. The cone of the Sun and Earth may be represented as follows: Their diameters being as 111 to 1, draw a cone with 111 as base $= 2\,R\,\sqrt{2}$ and 1 as apex, the height being 4 R and $R = 39{\cdot}3$, or 40 feet of the inscribed circle. The

opposing pressures of the atoms of the cone upon the base lines of its inner cones at heights, 2R and 3R, and upon the base itself, are such that the apex tends in one direction, and the whole of the base part recoils in another. The backward movement or recoil of the base, is, however, opposed by the cone behind it; and so, while there is a general intermingling of the cones, the apex is thrust off from the mass with the whole weight of its inner parts like shot from a gun. The weight of the Sun will, therefore, have a definite relation to the part of the apex thrown off, which will be the little cone with base $\pi\left(\frac{R}{4}\sqrt{2}\right)^2$ and height R, and the pressure upon its base will be (*vide* p. 3) $2\pi R^3 g\rho \times \frac{8}{\pi R^2}$. We shall show the value of $g\rho$ to be probably $3\pi R\sqrt{2}$. Hence the whole pressure will be $48\pi R^2 \times \sqrt{2}$, which equals (R being 39·3) 324,343.

If we subtract from this the weight of the Moon, which may be taken as $\frac{1}{75}$ part of the Earth's mass = 5,000, there remains 319,342 as the Sun's pressure or magnitude in comparison with the Earth. Professor Grant gives the value as 318,800. The Earth, being placed at the apex, presses upon every part of the Sun's equal diameter with its own weight multiplied by the height, so that there is equilibrium.

The velocity of issue is the same as that of water flowing from a hole in the bottom of a cask = $\sqrt{2GH}$. Now the height will be, not that of the two cones, but of the height which remains after the two have commingled together. The height, in fact, has been diminished to that of a sphere with an apex of one radius above it, and the apex to be driven off, has, therefore, only a pressure of 3R acting upon it.

The area of the base is $2\pi R^2$, and the weight of the Sun, concentred at it, is 2π, and this causes the action of gravity which presses by constant impacts in two directions with a resultant force = $\pi\sqrt{2}$. Twice the height of 3R and the force of gravity will give, when their square root is found, the velocity of the impacts given in a second to the atoms by the cone of base 111 and height 4R (R = 39·2).

$$\sqrt{2}\mathrm{GH} = \sqrt{3\pi \mathrm{R}\sqrt{2} \times 2} = \sqrt{6\pi\sqrt{2} \times 39{\cdot}2}$$
$$= \sqrt{1046{\cdot}2288} = 32{\cdot}342 \text{ feet per second.}$$

I need not say that this is almost exactly the well-known velocity of Earth's gravity.

If we apply this formula to the Earth's real cone we have $\sqrt{2\mathrm{GH}} = \sqrt{2 \times \pi \times \sqrt{2} \times 3 \times \frac{95000000}{4}} = 570{,}000$ miles a second. The shock of electricity is said to be 576,000 miles a second. Most of this vast force is consumed in urging on the gradually increasing mass of Earth's vapour in the intervening spaces ; but if we consider light to travel, as the resultant of electricity, around the surface of a body, not waiting to urge it on, but, like water running over a ball, just carrying forward the little outer layer of vapour, we have a close approximation to its rate of progress. The outer or curved surface of a cone, such as we have spoken of, is exactly three times the area of its base and $\frac{570000}{3} = 190{,}000$ miles a second. Light travels at the rate of 192,000 miles a second.

The distance to which the apex is hurled depends upon the breadth of the diameter from which it is formed. The sun can only pour forth a definite quantity of vapour, and that is the apex formed from its whole diameter ; but many different condensations can take place from that apex which will be scattered here and there through the heavens. If we could suppose a perfectly straight line of force to issue from the Sun, yet in a short time this would begin to bulge out in the centre, and diamond-shaped masses would accumulate at intervals, and crystals be formed ; so that Jeremy Taylor's idea of each planet having an angel to guide and guard it is at least a sensible one, and the pretty coloured stars are the rubies and sapphires with which God adorns the heavens.

The Sun's issuing vapour lies as a thin vapour upon the surface ; but the impact is from the cube at its back, and the distance therefore must be great to which it is sent.

The atoms describe a parabolic area, or rather a hyperbolic gradually reduced by pressure or distance to a parabola; the distance will, therefore, be proportioned to the square of half the base line, or it may be found by the usual formula for projectiles when the angle is known. The part of the Sun given off each moment is $\frac{\pi R^2}{8}$, or $\frac{1}{16}$ of the area of the base; but, as the Sun rotates quickly, the vapour must be considered as issuing from double the surface, or $4\pi R^2$. Hence the necessary base radius of the Earth's cone resting upon the Sun, from which vapour must be considered as constantly rising, is $\frac{R}{32}$. The value of R of the inscribed circle is 315,000, and the distance will be $\frac{R^2}{32^2} = 92{,}040{,}900$ miles.

Now that the transit of Venus is about to take place, it may be interesting to compare the result which will be obtained by observation with the above theory. The reputed distance, at present, is, at the greatest, 92,723,000 miles.

21. Experience shows that all bodies give off vapour. Now the result of this is, when considered in the light of the laws which govern the maximum density of vapour, that unless the proportion between the solid and vapour is as 3 to 1 or 1 to $\frac{1}{3}$, the vapour, not being able to support the solid, will at once condense; that is, will never leave the solid's surface, or, if it can do more than support the solid, it will go on condensing till only a quantity of vapour is left sufficient for the purpose. Both Sun and vapour must be considered as vapour in different stages of condensation; hence the Sun itself, unless there is a sufficiency of weight above it corresponding to that required by its temperature for its proper support or counterpoise, will itself condense and press in upon its inner parts, and at the same time give off a more refined vapour, till at last a sufficiency of vapour is left suitable to the temperature and pressure, and then a true counterpoise will be obtained by the Sun supporting the vapour, and the vapour requiring the Sun for its support. We all know that the

weight upon the safety-valve of a boiler must exactly accord with the power of the steam, if its real power requires to be known, and so the steam must exactly counterbalance the valve.

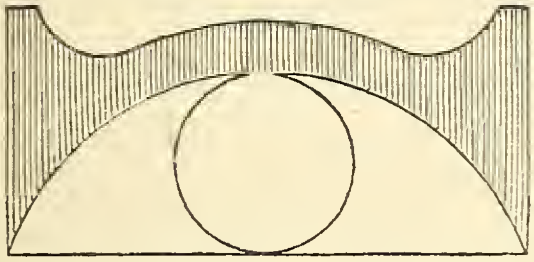
The peculiar property of a cone pressing with the weight of a cylinder of same height, and of a sphere being able to support three times its own weight, makes it very probable that this is the grand proportion of weight in the universe. Hence, if a body keeps giving off one-third of its weight, there will always be equilibrium at the end, for $1+\frac{1}{3}+\frac{1}{9}+$&c. will approach as near as possible to $\frac{3}{2}$, which a hemisphere resists, but will never actually attain that quantity. One-third of vapour will, however, exactly support one of mass if it is of the density of 21,000 cubic feet to a lb., and so the whole weight, pressing on the Earth, of vapour, or its representatives the Moon and planets, is no doubt one-half its own weight. It may be said that simple vapour, in the form of a cone, would be sufficient for the purpose, and that it need not have any force of steam, for it presses with a force of 3 lbs. by its own weight. Such may undoubtedly be the case, but the difficulty will be to find a vapour that has not some power of internal pressure apart from its power of falling; for my own opinion is, that, granting such a vapour to exist, it would by the act of falling not increase its capacity, but show its capacity of pressing with a force of 3 lbs. to the foot, and would acquire the proper temperature. Heat is the collision of particles already moving; and, given the capacity of pressing in all directions in matter, then the phenomena of heat, light, and weight, and probably electricity, colour, and all the other attributes, as they are called, of different forms of matter, would result as a necessary consequence.

22. The Earth's distance is not such as we should have expected from the length of its diameter, for its place would correspond with $\frac{R}{25^{th}}$ part of the Sun's diameter, and not with that of $\frac{R}{32}$ for $2\pi \times (\frac{1}{2})^2 = \frac{\pi}{2}$ and $R=40$. The reason may be that it has fallen

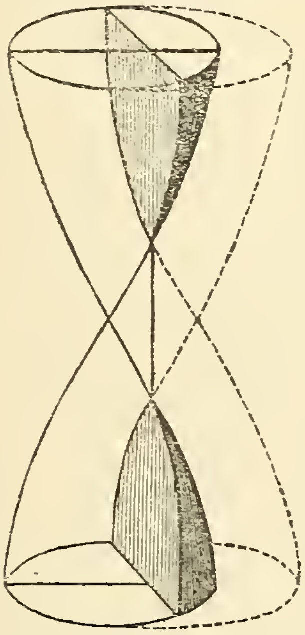
for support to the centre of gravity of its cone. Supposing at the place of the Earth's formation the Sun's momentum was 1×1, and that there was an equality of pressure until the Earth's condensation, and that the Earth then weighed 2. By the rule for impacts we should have, at successive impacts, $\frac{1 \times 1}{3} = \frac{1}{3}$, $\frac{1 \times 1 + 3 \times \frac{1}{3}}{1 + 3} = \frac{1}{2}$, and so on, $\frac{3}{5}$, $\frac{2}{3}$, &c. Hence the Sun's impacts are most effectual at the greater distances, and probably the distances are as the square of the diameter of issue; or if we supposed the case as it would be at the exit from the Sun where 1 lb. first urges on $\frac{1}{3}$ of a lb. and adds itself after every impact afterwards, the numbers would be— 1, $\frac{3}{4}$, $\frac{3}{7}$, $\frac{3}{10}$, $\frac{3}{13}$, which is much the same distance as the planet's locations, the Sun moving like the rest and from the same impacts, so that there would be a gradually decreasing speed given to the masses. The Sun's momentum would always be the same for small issues of vapour, for there would be nothing to stop it if we suppose the successive atoms which issue from it to condense when they reach the Earth. The Earth will, however, go on decreasing in speed up to a certain limit only. As it is governed by the same laws as the Sun, its vapour will constantly be going forth; but in consequence of its not having power to support the external pressure it will be crushed back to the Earth and only at a certain point, viz. when the surface of the Earth bears a definite proportion to the impacts it is receiving, and the quantity of vapour it can produce is able to support the Earth's weight will there be equilibrium. The Earth will then proceed in its course with a constant speed, giving off exactly the same amount of vapour that it receives, and not going further from the Sun. The cause of its circular motion I have already explained.

The maximum density of bodies is such that the issue or contraction of the outer parts depends entirely upon the inner density of the mass. It is at the centre that every change is felt, and from the centre every impulse is given. All bodies, therefore, tend not by attraction but pressure to the centre of the Earth. The central parts of the Earth are composed of closely-packed matter—a series of 64 cones with bases on the surface are all pressed in with their apices flattened in like the slides of a telescope, or rather the bellows of an accordion. When any portion vaporises there is first the telescopic action of drawing out the radius, and then a fan-like motion is produced or a pylonic curve.

23. I think those who are familiar with conic sections will find that the hyperbola best answers the description of motion or impulse which I believe to be guiding the heavenly bodies



An elliptical extrados to an arch.

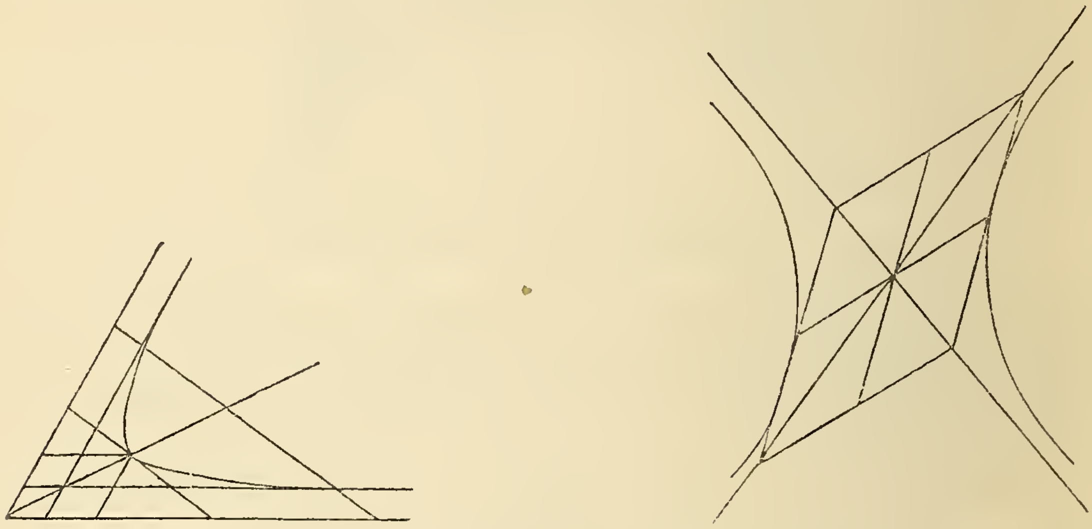


Hyperbola with the double cone, and hyperbolic extrados marked with dots.

There is first the appearance of the Sun, as shown in Keith Johnston's 'Astronomy,' with its remarkable four corners and cone-like protuberances, answering to conjugate hyperbolas. These cones are in the position that four cones would rest in when pressing north, south, east, and west (the east and west cones being due to progress in the air), and constantly resolving their forces one with another.

There is, then, the force issuing from the Sun as vapour, which whirls to its sides and compresses definite proportions of matter and returns in upon itself with a return blow. This forms a figure like that of the parallelograms at the vertex and asymptotes.

Exactly opposite to the Sun's outward thrust, or one branch of the hyperbola, is the corresponding branch, in all things like the first, and answering to the return thrust of the planets. Between the two is the diamond-shaped body or the parallelogram with its diagonals on the tangents, showing which way the force is going, viz. along the tangents of the curve; and, if we were speaking of the impacts from the north, this would, perhaps, show a further reason for the variation of the poles of the Earth from the perpendicular. The physical reason being, as I have suggested, that by the giving off of vapour one end gets lighter than another, and so each pole turns successively to the Earth, and so preserves the spherical form of the Earth, though each pole is somewhat flattened by the constant issue of vapour.



The parallelograms of an hyperbola.

There is also the remarkable peculiarity of a hyperboloid forming similar sections to the conic sections, though the conical form of vapour does itself imply that the forces vary inversely as the square of the distance; and as the masses are formed from the matter surrounding each point, and are proportional to the diameters, this is an additional identification of the theory I am urging with that of the theory of attraction, or rather with the laws which govern the universe.

24. A cone is a much more economical way of employing vapour than a sphere of equal height; and, as it contains a sphere, condensations can be produced readily from it.

A part of a cone may, however, be superseded by a parabola or hyperbola in the inner and more enlarged portions; and I would now suggest that the cones generally, and that formed at the back of the Earth in opposition to the Sun's thrust, may also be limited in volume by the use of an hyperbola and its area, so that the lengthy appendages we have been considering may be much shortened. The pressure sunwards may be caused by condensed layers resting upon the orbit of the Earth's circle, and supporting it or preventing its outward thrust, like the extrados of a bridge with a cycloidal, elliptic, or hyperbolic arch, probably the latter, though much may be said for an elliptical extrados. [The Earth's globe of matter would thus be going upon its course through the expansion of the air behind it, and would compress the air in front of it and down the sides of the arch, so as firmly to support it.] The Earth's motion in a circle would be formed by the rolling of the sphere on the surface of the Sun's northern cone, where it would be supported by direct impacts, and thus the pressure in towards the Sun would be prevented.

I think a strong corroboration of the views I am presenting to you is derived from this conception of the Earth's orbital motion. As at present explained, nothing seems more ridiculous to an untutored mind than the way the Earth rotates. A wheel going forward by twisting itself backwards seems something so uncommon that only a firm belief in facts has compelled its adoption. There seems to be only one way for a carriage wheel, or any kind of sphere, to move, and that is over and over itself from east to west.

Now, see how clearly the whole matter appears if my views are adopted. The Earth is suspended from the north; hence the motion will be that of a ball hanging at the end of a string and twisted round. We all know that the motion in such a case is naturally from west to east, or as the Earth spins, and that it requires an effort of will and a peculiar twirl of the fingers to send it the contrary way. Again, the Earth is resisted by the Sun by a cone of vapour extending to much the same vertex as the Earth's. The Earth rolls, therefore, round the outside of it as a carriage wheel would roll; and it is a well-known fact that there is no more perfect motion than that of two cones, with their apices together, rolling round one another; they seem to go round as if they could not help it.

There is one further condensation of the cones. In the hyperbola the cones are placed apex to apex, and the transverse axis is at one side. The cones are, however, but a remnant of two larger cones, having their apices intermingled and resting upon the transverse axis. The reduction is from a cone of 4R to a cone of 3R—a very important point to remember—and the reduction is in the proportion of 4^3 to 3^3. (See fig. p. 31.)

25. We come now to another very remarkable curtailment of volume which cannot be placed in the former list, which consisted simply of beautiful contrivances for making the most of the materials at hand. We have now a fundamental change of plan. It is a well-known fact, as regards steam, that if you increase its temperature it will be able to bear a much greater weight, but will do so by a great reduction in volume. For instance, 1 lb. of steam at 32° has a volume of 3,390 feet, but at 212° it only occupies 27 feet, but supports 2,116 lbs.; and at 428° it has a volume of only 1·393 feet, but supports 48,430 lbs. Now after an atom has been formed and condensed in the northern regions (or the south, as the case may be) and descends to the equator, it comes down at a sharp angle, and from being, say, 4,000 feet from the Earth, it approaches to 1,400; or from being 4 radii from the centre it drops on to the equator at $1\sqrt{2}$ radius of the cone's distance. This great approach of the Earth to the Sun would be such that its density would be too great for the Sun to support, if it were

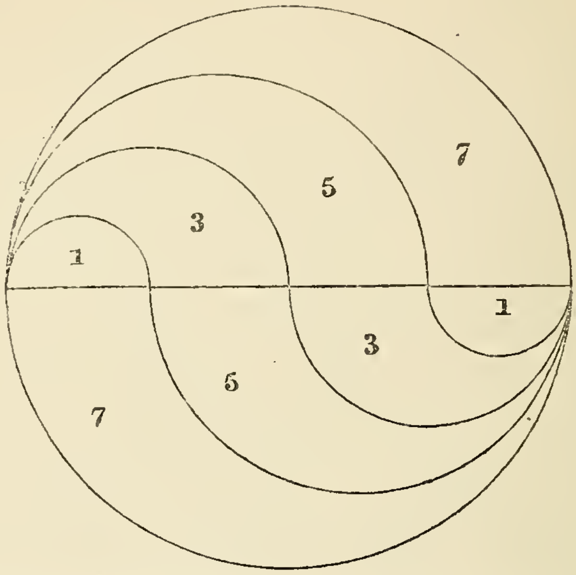
not for the fact that the pressure, impact, and fall of atoms on the Sun's equator, or between this and the Sun, has immensely increased the temperature, and consequently its power of sustaining weights, so that the Earth, though very much denser where it is than might be expected from the thinness of the vapour it has been composed of, is able to find rest. Here we find another corroboration of what I have previously stated, that the inner planets have sunk into their places because of their greater weight or density. Their density shows that they must have been formed at the very apex of the cone given off by the Sun; but Jupiter, Saturn, and the other planets are further away, because after being driven away, atom by atom, from the equator, in the manner I mentioned, they returned or sank back only to such a spot that the heat was sufficient to sustain them.

The masses of the planets on the equator may be considered as in equilibrium, so far as their motions up and down are considered; and on the equator they must be treated not with reference to volume but area—they may be looked upon as all placed in a flat circle. We must still expect, however, the same law to hold good of 3 to 1, and the problem is to find out how this is accomplished. First, the area of a circle being as the square of the diameter, if the circle is 4 feet broad, and if the Sun can place within the circle 3π of solid matter, then we shall have 3 lbs. weight of matter to 1 of vapour.

Secondly. As a sphere can support three times its weight, a large sphere of vapour can be kept within bounds by a mass three times its weight going round it, or by its going round the mass. Jupiter is three times heavier than Saturn; so if we suppose Saturn and its vapour to fill up the annulus between its sphere and Jupiter, and to roll on the outside of Jupiter's sphere, a great portion of the equilibrium is accounted for.

Thirdly. As the planets move in their orbits it is important to remember that when a diameter is divided into equal or *unequal* *parts*, and semicircles are described upon them, the areas are equal as well as the circumferences.

Therefore, in whatever place in its orbit a planet may be, the areas between its sphere of vapour and the next may be so



arranged as smoke curls that there is only the one force moving all, a definite quantity of vapour pressing with a force of 3 lbs. to 1 lb.

Fourthly. As each planet gives off vapour, and a definite quantity only can be admitted in the circle, it may be an interesting inquiry to find out the proportion each produces. I think this may be discovered by the aid of another of Hutton's[1] ingenious problems.

'Seven men bought a grinding-stone of 60 inches in diameter, and they agreed together that each should grind off an equal share, so that one beginning first should grind his seventh part off the stone, then a second should grind *his*, and so continue in succession. The question then was how much of the diameter must each person grind down.' The construction holds true also when the shares are unequal in any proportion.

26. I give now the figure of the solar system, which I believe to be a true one. (See frontispiece.) The whole system is contained within the parallelogram formed on the tangents to the curve of an hyperbola, and has been thrust into that position by surrounding pressure. The retrograde motion of the moons of

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[1] *Hutton's Tracts*, vol. iii. p. 381.

Neptune and Uranus may be accounted for on the ground of their nearness to a hotter force; and the greater density of both planets to Saturn and Jupiter shows that those two planets are receiving condensations from the resistance of the same outside force. The figure represents the solar system when viewed either as a flat circle or a longitudinal section, with the arrow pointing north. In the latter case, the figure must be considered as much larger in proportion, and the planets will then whirl round the arrow-headed axle, or an axle between that and the asymptote, and, by a necessary property of a hyperbolic solid section, their course will be that of an ellipse.

It is useless trying to guess at the place of the nearest sun, but I think an attempt ought to be made to systematise the groupings of the stars. The barbarous monsters of olden times still live in the heavens like tigers in the jungle of India. Many of the stars may be systematised by due consideration of the workings of cones. There are straight lines in Orion's Belt and the Northern Bear, from which stars have been thrust out of their position by the neighbouring stars pressing upon them, and many groups of cones and triangles are visible, which a person with a good knowledge of the stars might frame into a complete system. There is always a resolution of forces outwards where two cones meet, and along the line of issue masses are sure to congregate, for the centre is the only spot of rest from the action of the forces, and cusps of light will be visible *there.* If a cricket ball is placed in a tumbler, and the mouth of the tumbler be turned with a slight inclination to a strong sun, beautiful cusps will appear, and a fringe of light or a curtain will be formed over the whole surface of the ball, so like matter, that one feels tempted to try and remove it with the hand. This effect is due to the shadows cast by the compressed circular formations of the glass when manufactured, which are clearly seen if the tumbler is looked at in front of the fire. Two thoughts suggest themselves to me by this experiment. One is, that, perhaps, much of the effect of light may be due to the inclined angle of the Earth's cone stretching along the tangent of the curve. In the image of the Sun, already alluded to, there are strong markings upon the equator of a series of straight lines rushing upon the Sun from the planets. These are its rays of light, perhaps. The impacts of vapour upon the Earth first diverge and converge along the equatorial cones, and, meeting the curve of the northern cone, they are again concentrated at the centre into a bright cusp of light upon the Earth's surface, and this, being round-shaped, sends back the rays in every direction. The heavier atoms which come from the Sun by slower condensations, deposit themselves at the south pole.

27. The second thought is, that the lines or absorption bands of the Sun are due to the condensed air of the cones, which we look through in looking at the Sun. The condensations will be exactly like those of the tumbler, as the effect is produced from the weight of a body on the top of the column of air, and each kind of air will have its own way of packing—the heavier the body the greater the number of lines it will have. These lines are due to the overlapping of the material at those spots; hence there the air is denser, and consequently the atoms of light will not pass through the body at those divisions, but around them, so that shadows will be produced. There are gases like sodium, for instance, which only give one band or two of shadow. These show that sodium has only two vapours which can beat back similar vapour in the sun's rays. The other parts of the ray of light condense on the surface of the sodium, and transmit their light by vibration, leaving a gap of two dark lines.

The shadows of sodium represent, therefore, its most powerful rays, and these will be the bright lines on the screen when the rays of burning sodium are thrown and condensed upon a prism. The spectroscope simply reveals that between the earth's atmosphere and the sun there are vapours, and behind them an incandescent body, it may be of dense vapour only. With diffidence I would suggest that the vapours are derived from the planets, and that oxygen is the incandescent body. Oxygen has not been discovered giving dark lines in the spectrum, and it is condensed in its passage out from the Sun and made red hot by the friction which has ignited the hydrogen. No one can doubt that gases and metals have peculiar marks by which they may be known by spectrum analysis, and no one can doubt that those marks are plainly visible in the solar rays; but I cannot jump to the conclusion from this that the Sun is red hot and is surrounded with burning gases. In looking at the Sun we look at it as we look at the cricket ball in the tumbler, in the middle of a cone. An ordinary tumbler (with its inside-bottom somewhat hollowed out and its outside-bottom slightly concave with octagonal sides), when turned upside down and looked at by gaslight, gives a very bright silver look to the curved inside surface, and we may expect, therefore, that when the round Sun is looked at through an inverted cone filled with matter it will have much the same appearance. I never can believe, though the pressure upon the Sun's equator must be enormous (but not relatively so), that the Sun is red hot, more than I would expect an inhabitant of the Sun to believe that we were all being boiled on the Earth because we endure a pressure of 2,116 lbs. to the square foot.

28. There are one or two points concerning light that I should wish to make a slight digression upon. Light, to begin with, cannot go through a brick wall, nor go down to the bottom of a mine, nor pass through the flimsiest piece of cotton velvet, nor get behind a looking-glass with a mere shadow of mercury behind it. It has only a limited power of going round corners; for shadows are universal, and twelve hours of every day are spent in darkness. Artificial light requires oxygen and burns best when flat, as when it issues from a gas-burner, and requires not to be too dense, for the top of the flame is the brightest; nor yet to be too rare, for hydrogen, the lightest of all gases, gives little light but great heat. When hydrogen and oxygen unite great light is given out. Besides all this, we find that it appears

to pass readily through glass, and to go through water, and to enter the smallest crevices. It is unable to pass through gold in its ordinary state ; but, when it is reduced to a very thin film, light is visible through it. If we try to get something orderly out of these various qualities, we might first conclude that light has less momentum than air, for air can enter a dark room and to a limited extent get down to every part of a mine ; and this is what we might expect if light is an issue of matter from the Sun, for the air is the accumulated momentum of millions of miles of matter from various sources, and has received numberless impacts in its course, whereas light has skipped here at the rate of 190,000 miles a second.

It seems probable also that light, as a general rule, never permeates anything—it hits it, and nothing more ; it can almost knock down the film of partition in gold leaf, but mercury is too much for it. If light really had the immense power imputed to it of permeating dense glass and vast bodies of water, it would knock down a stone wall in a very short time ; it must hit everything alike, and its effects are a mere nothing. Cathedral glass and such things show some effect after hundreds of years, but it is a mere surface effect at the utmost. By constant thrusts the light manages to show that action and reaction are not exactly equal and opposite even in matters of light and flint glass, and some of the atoms of the surrounding dirty air become imbedded in the glass. But it may be said that the undulatory theory of light gets rid of the difficulties of the emission theory, but I cannot see it. What are undulations? They are the results of motion upon a body. The waves of the sea have a cause ; the wind stirs them, but passes on itself. The waves move ; but as they are 800 times heavier than the air, they only move with less velocity. The only difference, therefore, between the emission and undulatory theory is, that the latter makes light give a blow 800 times heavier than the former, and move immensely more slowly—two improvements which do not commend themselves as worth adopting. The interference of light and heat are produced as evidences of the fact of undulation; but I should suppose that no one doubts that the wind moves up and down the waves that have been produced by the preceding blasts; its own waves follow it. The question is, What is light? Is it a thing that you can square and cube, or is it that great resort of intelligence, an 'inherent quality of matter'? Undulations move—that is the first great fact; it was once thought that they did not. Hence the theory was produced as a kind of explanation of velocity; but let us now go back to first principles and try and find out what light is, and what produces it, and not content ourselves with saying a thing undulates, without looking to the cause of undulation. I have no doubt matter does undulate and go round every corner where there is a short cut; but what makes matter undulate so as to produce the matter we call light, or the perception of a blow to the nerves which we call light?

It does not require to be of any definite colour, appearance, or size, and probably by the time it strikes against a window pane its velocity has been greatly decreased. That which strikes is not the original atom, but the resultant atom of many rebounds and compounding of forces.

29. Light propagates itself from atom to atom by condensation of vapour, impacts and expansions.

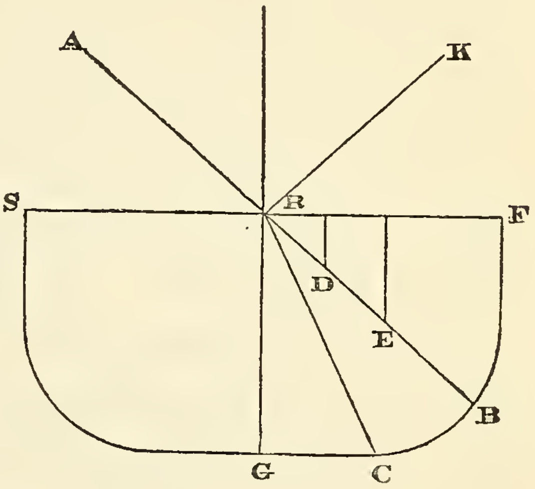
On meeting, say, a piece of glass surrounded by vitreous vapour, the air-waves condense upon the surface and strike it as they fall; the blow is transmitted by refraction and mechanical laws to the other side, along with the greater part of the heat caused by the blow. The glass then hits the air next to it, condenses it, and compels it to give out heat. An expansion of the air follows, estimated as 580 times that of glass for the same amount of heat, and thus the original blow is carried forward with almost the intensity with which it was given to the glass.

When coloured glass is used the oxide produces a vapour which has not such an affinity for vapour as the rest of the glass; and its power or tension being equal to that of a certain sun's ray, it beats back the ray of the same density as itself; but the other rays condense upon it—this is what is meant when it is said that colours absorb every colour but their own, and emit their own rays. The range of refrangibility seems to depend on the force of each separate vapour's condensation, but heat travels in straight lines faster than deflection can take place by some cushioning effect. As it can only move by resolving its forces, light must have momentum. It is because of the great lightness of hydrogen that it cannot burn brightly. It chafes against the surrounding air and is beaten back, and so only produces heat or a violent commotion of its parts. Light is unable to enter into a mine or behind a velvet curtain. In the first case because it dashes against the different sides of the mine and destroys its force, especially as it meets heavier and denser air at every turn; in the other, because the moving atoms get caught in the pile of the velvet, as it were, by so many arms.

30. Water and glass appear certainly to transmit light, but this may be due to other causes. Glass is a particularly brittle substance, and, as we know, is peculiarly sensible to vibrations, so that by striking it, or running the finger round a finger-glass, loud sounds may be produced: its atoms, therefore, move backwards and forwards with great ease and with a spring. It is also rounded, smooth, and polished, so that an atom of light on striking it sideways does not resolve its forces in two directions within the glass, for it would thus produce an expanding opposing cone which would soon stop its progress, but resolves one force along the surface and the other through the glass, so that a single line of atoms only is moved, and the last atom of this single force gives an impact to the air inside the window of the same kind, but of less power than the original force. Lenses are made of soft glass, so that they may act like water and turn the internal resultant force accurately to its focus. Mercury placed at the back of a glass reflects the light because it is a particularly mobile globular substance of bright surface and of

great comparative weight, and so reflects the light in every direction, instead of moving. On meeting the glass again these lines are reflected along the surface, and return on exactly the same principles that any body would move when struck.

Water, though incompressible, is much more movable than glass, so that it does not spring back and reflect light so readily, but the movement of its parts produces a strong refraction. Thus, let A B represent the force of impact. When the atom of air impinges at R it has a direction caused by the forces acting outside the vessel of water; but the atom of water which proceeds to D, E, &c., has to bear the weight of the water above it, and is consequently twisted out of its direction and proceeds to C, for the force of impact is the same as if a column of water along R B had been scooped out of the vessel. The lower part of the water, therefore—that is, the water in the triangle R G B—would sink from R downwards, in order to find its level, and the upper part fall with the force of gravity, so that R B would gradually arrive at R C.



The reflected ray is caused by the same simple principles. On the ray striking at R it causes a condensation or dislocation towards F and G, and indents itself in the liquid. R F has not sufficient momentum to return the blow, for it is on the surface, and had only power to place an atom there without velocity; but R G has the full force of the liquid or of the compressed cone that was formed when the blow was struck: it therefore presses perpendicularly upwards. On the side of S R there was evidently a slight vacuum produced by the side thrust of R, and S R therefore expands itself, or atoms thrust themselves into the vacuum, and the combined thrust of S R and G R sends the atom in the direction R K. I really think, therefore, that Sir Isaac Newton's corpuscular theory of light ought to be maintained. It does not at all imply that every atom should proceed direct from the Sun without meeting anything upon its course. There may be, and probably is, a range of atoms, and the movement of each may be indefinitely small; but the momentum is the result of direct impacts, and whatever the course of the atom may be when struck—whether plane, spherical, conical, or undulatory—the origin is that one great source whence every quality of matter has its birth.

31. It is difficult to form any conception of the electric force, which is apparently the representative of the full power or velocity of the Sun. At first I supposed that this force must be a series of straight lines, or the straight thrust and shock of the Sun's weight, and so, perhaps, a great plain over which the force was distributed, and which would serve as the lines of railway, as it were, upon which the later condensations were to glide. Many of the known powers of electricity are against such a conception, so far as this Earth is concerned; but the following, I can hardly call it hypothesis, agrees generally with the action of electricity.

A straight line of force proceeding from the Sun meets a preceding body going more slowly than itself, and at once bends and twists itself, or with its revolving lines generates a cone as it thrusts its way through the mass. It thus becomes a great coil of matter, twisting with incredible rapidity and with a hollow in the centre. Down this hollow, as the place of least resistance, the preceding matter enters, so that the action is like that of a cheese-taster thrust into a cheese. The matter is condensed when thrust into this coil, so that only in front of it, or towards the Sun, is there a way of escape or expansion. If we call the original thrust positive electricity the condensation will be negative; and they may be said to differ one from the other as a devouring element differs from an exuding; and this reminds me of an opinion I have long entertained, that the places of eating, &c., in all living things are placed at different ends of the bodily framework from some occult connection with electricity and the poles of the system.

It is a peculiar quality of electricity that it is (like light) a surface force, or at least prefers being outside ; I think, therefore, that, as electricity enters the mass in front of it, a constant resolution of its force takes place and light is formed, which will bear the same relation to electricity that the surface of a cone does to the area of its base, and will, therefore, have one-third the velocity of electricity. I have heard of electricity being produced by the exit of steam from a vent. Is it not probable that the Earth's electricity may be due to the same cause—the issue of steam from its poles ? As the atoms descend from the north, they twist or rotate southwards, and thus the issue can only be from the pole that they left behind. Magnetism is probably the flow of atoms all in the same way, and any minute body will, when nicely balanced, point to the place of steam issue, like the needle does. A piece of iron is made a magnet by being smoothed in two different directions by a magnet, and the air atoms, or any other atoms, will naturally run down those roads more readily; and little atoms placed by the magnet's side will point in the way of the current by mechanical rules, or north and south poles will affect the atmospheric or other pressures between them when placed opposite each other, and attract or repel, as it is called, according as the intervening spaces are free. Two currents of air meeting destroy force, and pressures from behind will then thrust the two bodies together. Let me write a few lines on this point, for it is the essence of electric science. It is well known that vapour rules its issue from water only by the amount of other vapour present in the atmosphere, and pays no regard to the air or carbonic acid that it meets. But vapour meeting vapour follows the rules of maximum density for the temperature. If it meets vapour exactly similar to itself, the two will simply strike and rebound into space (if they have not reached their limit of density), or will radiate from their centre ; but if it meets vapour of another density there is a condensation. The important point to notice is, that this law holds true for all vapour, whether of hydrogen or of iron; and a second fact is, that every known body gives forth vapour. When, therefore, a piece of glass and a piece of resin are rubbed together, one having greater specific heat than the other, the steam of the glass will become more powerful; and so when they are brought together, after being well rubbed, they will appear to attract, for the steam of both glass and resin are different, and neither can support the weight of the other, and so condensation takes place, and they fall towards one another; that is, the impact of the two balls of steam was such that the one completely overpowered the other and entered it, forming a vacuum; but when two pieces of glass are rubbed together, or two pieces of resin, or two pith balls similarly electrified—that is, having a layer of the same steam encircling them, and are then brought together—we have the case of steam of similar density meeting in a large room. When the collision takes place neither is able to enter the other, there is perfect elasticity and they rebound, the air at their back gives no resistance, and so the two bodies appear to repel one another.

32. The same is exactly the law relating to magnets; but the difficulty is to find out how, without being heated or excited, they can retain the constant power which we perceive. I think it may probably be due to the rubbing-down process in forming a magnet which induces a constant current of air to run down each pole, and we know that a constant stream of air passing over ice or water evaporates a good quantity. The attachment of the armature when the magnet is not in use hinders this current, and so preserves the little channels from being worn down, and thus keeps the magnet's force from being dissipated. It may, perhaps, be necessary to state, that when a piece of rubbed resin is placed in front of a pith ball that has not been rubbed, attraction takes place, because the steam cannot support so many pounds on the square inch as the pith ball weighs. After the two have touched, the sphere of the pith ball clothes itself with stolen garments, and repulsion takes

place in the usual way. The weight of the balls is supported, and the thrust becomes one of vibration, so that less force is necessary. The armature of the magnet is generally so heavy, and so small, and so cold that the little steam it obtained would condense on its surface as soon as received, or nearly so; so the same repulsive effect would not be produced.

In most cases of petty electricity I believe the vapour to be simply that of steam of low density; but in the higher branches, where there is chemical dissociation or telegraphy, where the influence of an atom's movement is felt thousands of miles off, then the atoms at play must be of great density, and endued with a velocity, or at any rate a momentum, somewhat equal to that of the Sun's atoms.

The case of the magnet's attraction and repulsion can only hold good, as above described, on the supposition that there is an atomic, or some other difference, which induces one of the poles to give out a rarer gas than the other. If this appears improbable, and it does so to me, we may suppose the north and south pole of each magnet to be constantly destroying the effect of the other by running back one upon the other towards the centre of the magnet. This may occur from the fact that only one of the two can take the outside; and the inside electricity is therefore destroyed, or condenses as in the manner mentioned as regards the Sun's electricity. When two magnets, therefore, are brought together, the forces will be 1 (N—S), (N—S)2, if we suppose the poles S and N of the opposite magnets to be placed opposite one another. The N and S of magnet 1 meet and destroy N, S proceeding to N. The N and S of magnet 2 meet and destroy N, S proceeding to N. In this condition we shall have S—O. S—O pointing in the same direction S, that is, giving forth vapour to the left of the page, the inner S thrusts its vapour upon O, or the end of the magnet opposite; but, not being able to support it, O falls toward S, and S's vapour condenses as O falls upon it. This would represent attraction. In repulsion the magnets would be placed S—N, N—S. In the first magnet S would destroy N and proceed to

N's place; and in the second, S would destroy N and proceed inwardly to N's place. The magnetic forces would then be O—S, S—O; S and S would give forth their vapour, which would be exactly similar, and therefore these two forces would rebound and endeavour to fill the space around them.

I much prefer this view of the action, but it is contrary to the general idea that the north and south poles are constantly pressing outwardly. It is plain, however, that as new vapour arises, there will be a constant recreation of N and an interchange of position.

The magnet only attracts iron because its atoms have great velocity, and are spread around the magnetic field. Any ordinary substance, therefore, when brought near a magnet has already a coating of its vapour upon it, so that there is no condensation, and it, perhaps, behaves as atoms of air do with vapour. The magnet does not repulse it, because there is equal vapour upon the other side; besides, it may be that its atoms are exceedingly light, so that the effect of their impact may be imperceptible. The armature is attracted because it has a lighter coating of the same vapour upon it, and, being unprotected by sealing wax, &c., it may be able to condense the vapour it receives rapidly.

I think the reason that atoms of any gases when commingled behave to one another as if the foreign gas were not present is, that the lighter gas surrounds the other, so that the latter becomes like a particle of the lighter gas, and is expanded or condensed with it, or is carried up and down with it; for, of course, its substance is not changed.

33. It may be worth while to consider whether heat is not entirely connected with pressure. The fact that the pressure of 2,116 lbs. in the foot is the pressure from the Moon, and that the heat of the Moon on the Sun's side is probably that of boiling point, is certainly suggestive. As I have already said, I believe heat to be the destruction of motion—a mark left of motions having crashed together, or of a body

having more motion stored up in it than is wanted to resist gravity, but being unable, from surrounding pressure, to give off that motion quickly enough. Perhaps this is why we have vibratory vessels for the perception of light and sound, but the pressure of any part suffices for heat, which is a mere stoppage of motion. Indeed, there is such confusion of orderly motion where heat is present, that I think the ear is specially guarded by wax, &c., to exclude heat, or to convert it into orderly motion, and we know the eye is almost insensible to heat rays.

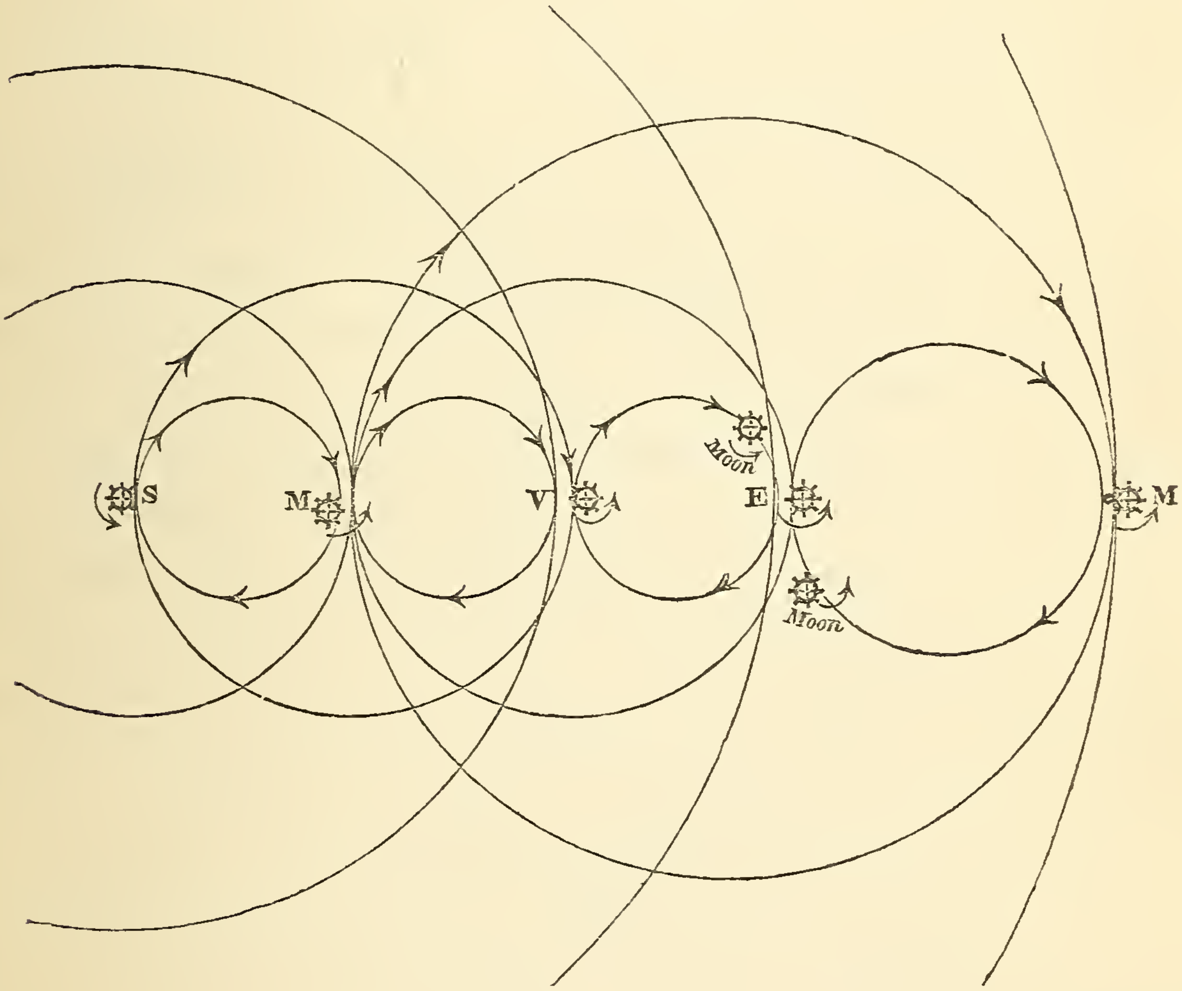
I have seen in an electric Geissler's tube the electricity beautifully visible, and the experiment showing clearly the action of the elements. First, there was the coiling circular motion of the original force surrounding its attenuated condensations. Then at a small hole, where there was an escape permitted, the force rushed over the side and vibrated till it came to another entrance. (Vibration seems to me to be the mode of quickest passage against resistance—a constant resolution of forces and the procession of the diagonal.) At one pole was the constant evolution of vapour, and at the other the paraboloid of resistance and the bright cusp of light in the centre.

The references I have made to the impacts of steam balls and momentum generally may require a word. When a mass of any description presses another, it naturally produces in front of it, from the resolution of its forces of impact, a cone of matter, and in course of a period of time regulated by the cube of the distance, that is, the increasing size of the cone in front of it, the resistance is sufficient to stay the blow's further effect. If a very thin layer of force is resisted, the return pressure might be supposed to act in a plane area, and thus the square of the distance would be the formula; but recent works on projectiles incline to the formula of the cube of the distance.

If 1 lb. of momentum were to penetrate into a mass so as to produce an opposing cone of 64 feet, of which after penetration it should occupy the lower layer or two, the cone having an inherent power of occupying 64 feet would again press forward to regain its old position, but it could only occupy 64 feet when there was nothing to oppose it, and now it has to eject a pound, so that the return of the pound to its former position would not be perfect. Hence, also, in vapours at their maximum density, the return thrust of the blow is always a shade less than the impact, and new force has to be applied to keep up the temperature, which would otherwise endure for ever. When a wall is struck it is not the whole wall that returns the blow, but a cone's length of the ball's striking force. Perhaps this simple explanation may commend itself quite as much as long formulæ relative to the conservation of energy, work to be done, &c., which never made things very clear after all.

34. If, as seems probable, the impacts from the Sun are tangential and similar to the blows given by a revolving circle, the figure of the ellipse might be accounted for by supposing an epicyclic train dependent on Mercury. The shaft being the series of planets, and Mercury's circle the eccentric round the Sun as axle. As the Moon has apparently no atmosphere on the side nearest the Earth, through constant condensations of the Earth's atmosphere on its cold surface, its motion will be regulated by Venus and Mars, which have not expended their vapour on moons. The Earth and Mars will receive their reflected motion from Mercury, and Venus from the Sun. The larger circles represent the direction of the forces. The little circles shew that there is also a motion from planet to planet.

It is important to notice this cog-wheel motion of the bases of the cones between the planets and the Sun ; for it will explain many difficulties and will account for the retrograde motion of the satellites of Uranus and Neptune and the return of vapour to the Sun. The dependence of the inner planets upon Mercury and the friction produced tend materially to lessen the velocity which it would have otherwise revolved with from its neighbourhood to the Sun. The ratio of angular velocity is equalized in all, and the motions are made much slower than the original velocity. Each planet has a vapour surrounding it with a motion the same as that which it turns with, but this vapour at its outskirts tends to send vapour which it *meets* in a contrary direction,[1] and this produces a kind of cog-wheel motion which is transferred to the next planet. The planets must always roll upon cones going the wrong way or they would acquire an accumulated velocity. This is simply saying that every planet always meets resistance from the air, which acts like flowing water upon an undershot waterwheel.



I have drawn two figures which may perhaps explain what I mean. In the figure of the greater planets I have shown the two cones as they move backwards and forwards, through the expansions and contractions of heat, the planets being normally at equal distances. In the interval between Saturn and Uranus there is empty space into which Jupiter pours its vapour, not being able to reach Uranus, which is urged on its course by

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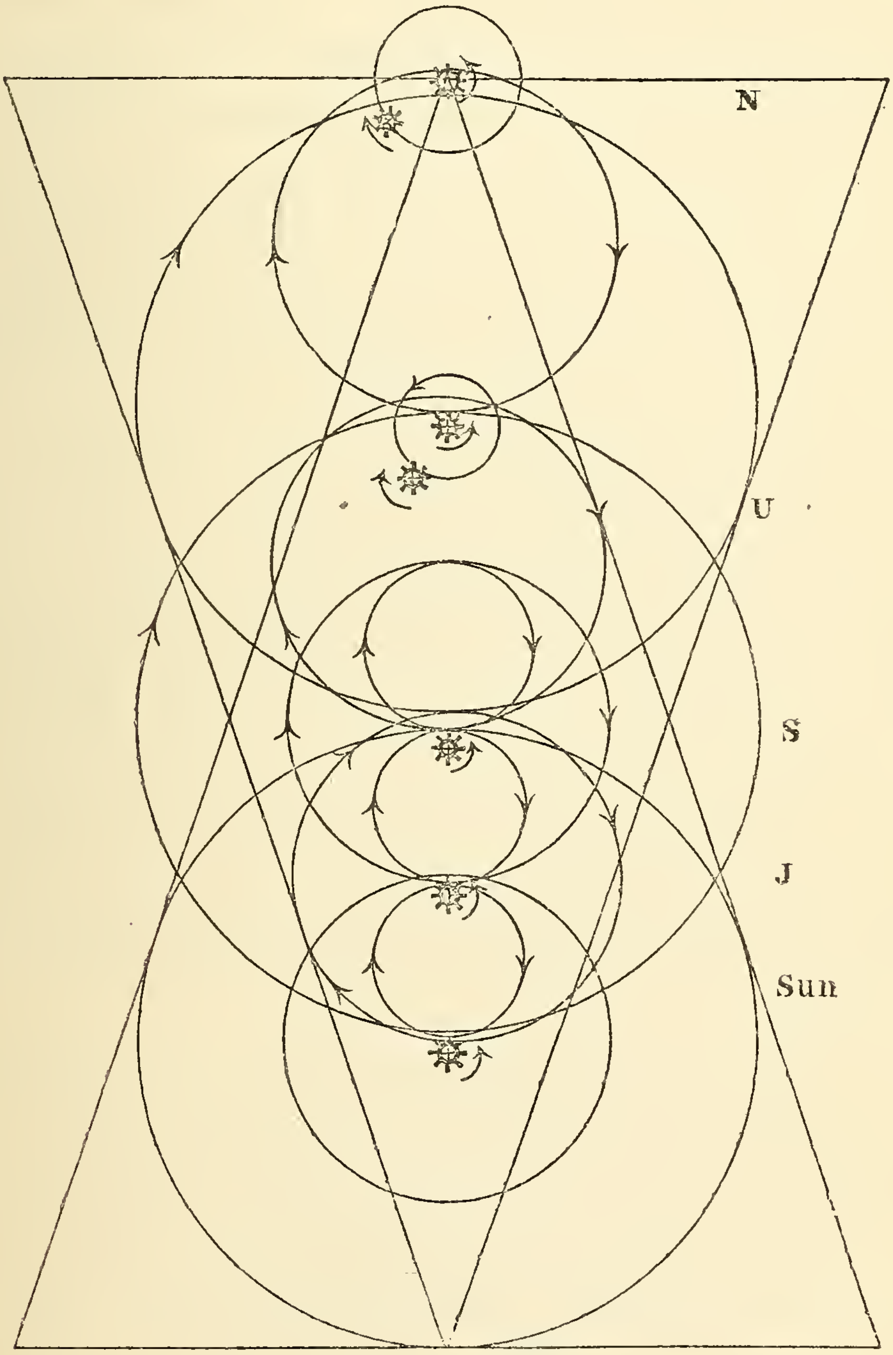
[1] Tait's Dynamics of a Particle, para. 127.

Saturn and the Sun. Jupiter and the Sun have been drawn towards the centre.

35. As regards the motion of the satellites let us remember what I have said concerning translation and rotation. Condensations proceed from the hotter air which falls upon the cold surface. Thus the planets condense vapour upon the side facing the Sun, and the breeze or expanding thrust is caused by the cold air rushing in upon the hot air; or the body may be said to be too heavy for the support given it, and so falls to the centre where the condensed air has left a free passage, but is turned on one side by the breeze behind it.

This is the general rule, but the Moons are exceptions. The Earth's Moon proceeds on its course through the influence of expulsion, or, what is known as repulsion in electricity. It requires a certain diameter in a body to reflect light and heat sufficient to cause a moon to follow it. The Earth receives exactly the same Sun impacts that the surrounding air does, but as it gets hotter than the surrounding air its vapour becomes stronger, and so precipitates itself constantly. The Sun still continues its impacts on the Moon thus formed, but as the Moon does not turn round to it quickly, its atmosphere on the Sun's side gradually conforms to that of the Sun itself. When this occurs a momentum is at once given to the Moon, and as the Earth has created a vacuum, it falls towards the Earth or goes in a tangential direction like the planets generally, the Moon rotating slowly under the influence of the Earth's previous and continuous impact. On the other side of the Earth, the Moon is acted upon by the Earth exactly as the Earth is by the Sun, and it receives its rush of cold air from Mars. As the Moon recedes from the Sun's side, its hot surface must precipitate the air coming from Mars, and, to some extent, this may be felt by changes in the Earth's atmosphere; perhaps this may account for the popular belief in a change of the weather at the new moon.

There is a large accumulation of vapour between Saturn and Uranus, due to the action of Jupiter and vapour from Saturn, and as it has little velocity and little heat this may be the reason of the many moons and rings of Saturn. The peculiar retrograde motion of the satellites of Uranus and Neptune is due, I may suggest, to the fact that perhaps the greatest cold lies between Saturn and Uranus, and from that distance onwards the spaces get hotter again. It may, however, be that the winds produced by the two planets are simply the vapour received from the Sun, but made hotter by the friction of rota-



tion, or the concentration of heat rays by the masses of the planets.

The air of Uranus being hotter than that of the Sun, and, therefore, more dense, gains the ascendency in the whirling motion of the spaces between it and Saturn, and meeting little opposition it expands, but does not change its direction of motion. Its Moon condensation is, therefore, one of attraction, for it cannot support the weight between it and the sun, and there is a falling to Uranus, but the rotation will be different in direction to its own, for the rushing of the air of Uranus against the globe of the Moon causes a friction on its surface, tending to twist it as one cog-wheel twists another or gives it a retrograde motion. Each Moon is diverted to an orbital course, because as it turns round from the heated side of Uranus it intensifies the current of cold air setting in from Saturn. The whirl of Uranus's vapour gradually extends down upon that of Saturn, and by degrees gives it an impact in a direction contrary to its own, and thus the return of vapour to the Sun takes place, so that the air may be said to be constantly ascending towards Neptune on one side and descending on the other, each vapour beginning hot and ending cold. The motion of Neptune's Moon is similar to that of Uranus, for the whirling vapour of the planet is hotter than that which surrounds it, and hotter than that which it receives from Uranus.

36. We have stated that the planets have been produced by condensations of apices of cones proceeding from the Sun, hence the Earth's mass may be estimated easily. Herschell gives its weight as being 13 quadrillions of pounds, and this multiplied by 21,000 will give the volume of vapour from which it was derived = 273,000 Q. The Earth is a sphere, and derives its mass from the whole orbit of the apex's revolution; therefore, the apex being $\frac{1}{64}$ of the conical distance from the Sun $\left(\frac{R}{64}\right)^3 \times \frac{\pi}{6} =$ volume.

Taking the distance as 5,120 × 10^8 feet, or 96,000,000 miles,

$$=\frac{\pi}{6}\times\left(\frac{512\times10^9}{64}\right)^3=\frac{\pi\times512\times10^{27}}{6}$$

$=268{,}000\times10^{24}$ of vapour,

= nearly 13 Quad. of lbs.

The Sun is the condensation of the apices of all the planets, and is also their origin, and there will be a proportion in their weights, for if you draw a cone and from its vertex cut off spherical segments, the areas of these segments will be proportional to the squares of their radii. The sum of all the solid angles which can be formed at the apex is $\frac{4\pi R^2}{R^2}=4\pi$; but as the Sun sends out in return for every condensation it receives a similar one, its solid angle will be the solid angle of all the complete conical surfaces[1] only, or of one-half the cones, and will be equal to 2π, which is the value we have assumed throughout as its weight. The height and width of the cones make the spheres mere surface weights upon the bases. When a sphere of vapour is formed the inward parts begin to concentrate upon themselves, and as it contains 4 cones of its own height, and each of these is equal to 2 smaller spheres of $\frac{1}{8}$ the volume of the sphere, each little sphere is pressed upon by the other 7, and becomes reduced in size, according to Boyle's Law, to about $\frac{1}{8}$ the volume, allowing for expansion or crystallization, or a sphere upon half the diameter. I have, therefore, in my figure of the Solar System, drawn a large circle round Neptune's orbit of twice its diameter, or with radius 60 R of Earth's distance. If the Sun were derived from one apex it would be from a cone of 69 R in height, $1^3 : 69^3 :: \left(\frac{R}{64}\right)^3\times\frac{\pi}{6}=328{,}509$ times Earth's weight, and we might have expected the circle to have been at that distance, but it may possibly be that the condensation of the planet is in the centre of a sphere of 9 R of vapour. If, therefore, the Solar system at present known to us is not complete, and if another planet exists, apart from the asteroids which may be scattered throughout the intervening space, it will be pressing upon the Sun's sphere at a distance of 60 R, and will be a moon worthy of the Sun's mass, and probably $\frac{1}{75}$ of its size. The inner series of planets ends with asteroids, and we know that meteors and comets come from the limit of the other series; and as Jupiter follows the inner series, we might expect a large planet to follow Neptune's meteors.

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[1] Sir W. Thomson on Electro Statics, p. 56.

I have noticed that there is a kind of balancing of the planets around the Sun, the place, therefore, of the unknown will, perhaps, be found by watching the parts of the heavens where Saturn and Jupiter may be upon the same side of the Sun. It may be exactly opposite or far back upon the same side, for it has sometimes struck me that the planets often serve the purpose of an umbrella, and thus the unknown planet might intervene to protect the Sun from undue impacts, while the two heavy inner planets were both pressing upon one side of it. Sun spots are produced by this diversion of impacts causing an increasing and then decreasing condensation of the Sun's vapour, and an inward rush of vapour to the Sun.

37. I have stated my belief that the sun is no hotter than other parts of the Solar system, or only slightly so. The great consumption of fuel which would be required to heat it, the impossibility of life, such as that upon the Earth, being sustained in its burning atmosphere, the improbability of heat being felt 92,000,000 of miles off even from a red hot sun; these and many other reasons might be given which would incline scientific men to accept any other hypothesis if it could explain satisfactorily the cause of heat. The heat I assign to the Solar system is as follows: Sun's vapour, or that of the whole inner series of planets, 212°; Jupiter's vapour, 203°; Saturn and Uranus, 194°;

Neptune, 212°; being a decrease of 9° for each, followed by an increase. If there is an increasing pressure towards the centre of each series, so that the vapour around each of the larger planets gets somewhat hotter as it approaches it, the utmost will be, I think, to make the Sun's *internal* heat 284°; and the smaller planets will increase in heat, from the Earth at 212°, by about 18° each, including the Moon as a planet. Each planet will be at the centre of gravity of its own northern cone, and will be supported by vapour at its maximum density upon the side of its base nearest the sun, upon which vapour it will rest as it rolls upon its orbit. It will be unnecessary to take into consideration the side pressures between the Sun and a planet, for these must be equal to the direct pressure, or the body at the top of the vapour would sink nearer the Sun by the bulging out of the column of air supporting it. If such vapour really exerts the pressure suggested, then the distances of the planets will exactly correspond with the volumes of steam at the temperatures assigned. These volumes are by Rankine's tables 26·36 at 212°, 31·26 at 203°, 37·26 at 194°, and 44·7 at 185°.

Mercury being the densest of the planets will be surrounded by the hottest vapour, but it is not unlikely that the smaller planets take off a good deal of pressure from the Sun's surface, so that the average heat may be about the same, but perhaps getting somewhat less towards the outskirts of the system. The Earth is about midway in distance, so that if the Sun is the least hot, or if it be Mars and the asteroids, still if the general heat is 27 and the Earth 26·36, about ·64 would represent the increase or decrease of heat through 92,000,000 of miles. It is unfortunate that the reason for the increase of steam in definite volumes for each temperature has not yet been discovered, and that no regular law of sequence or ratio has been found out. Without such definite knowledge painful guessing is all that can be attempted. Thus it is known that a gas increases by ·366 for every 100 Centigrade degrees of heat.

Now this may be caused by the unfolding of the apex of a cone within the volume. The volume we have seen is $\pi(R\sqrt{2})^2 \times \frac{h}{3}$. If the base is 1, then the height being 4 R and base $2R\sqrt{2}$, we have $\pi \times (\frac{1}{2})^2 \times \frac{\sqrt{2}}{3} = \cdot 366$. It is possible that every degree produces an increase of ·366, which the vapour in which it permeates reduces by Boyle's Law to ·00366. If this should be the case, then the increase in the volume of boiling water from 1 to 1·047 may be accounted for, for water is about 800 times heavier than air, and the pressure, therefore, will be upon one hundred atoms of ·366, each striving to rise through the water $\frac{\cdot 366 \times 100}{800} = \cdot 0457$. I have usually looked upon this remarkable swelling up of water as produced by cone-formations. Every sphere contains 4 cones of its own diameter in height; on the issue of vapour from the sphere, the water is expelled upwards against gravity, and in resisting gravity the vapour within the water takes the form of a solid of least resistance, or presents the appearance of a cone, until at last it can overcome the pressure and rise from the liquid, $\frac{4\pi R^3}{3} \times \frac{\pi}{3}$ will represent, therefore, the increased volume, or 1 volume will become $\frac{\pi}{3} = 1 \cdot 04719$. In the formation of ice, the vapour gradually subsides, and there is no internal motion of the parts to prevent the natural directions of the lines of force, so that although vapour is not present to present a conical resistance, the water itself presses equally against the air and Earth, and its cones lie side by side or the circle becomes a square. When the external and internal pressures are equal, crystallization results at every centre of gravity in each little cone, so that here and there throughout the ice minute cavities are found. The first formations take place on the surface of the water, or at the common base of the air and water pressures, and the increase in the volume of the water will become $\frac{\pi^2}{9} = 1{\cdot}096$. Water is known to expand about $\frac{1}{10}$ on becoming ice.

In steam, $\frac{21,000,000}{333} = 63,063$, or the radius of the Earth divided by the weight of a foot of earth, represents the utmost tenuity of the vapour. The pressure of the atmosphere from the Moon to the Earth, or 64,000lbs., would compress these 63,063 volumes into 1 foot of steam, creating a heat of 768°. This would be the greatest comparative volume which the steam could assume, and in the polygon figure on page 13, both volume and pressure would be represented by the outer square. From this temperature to that of boiling point the pressure produces greater effect, so that at 212° the volume would be represented by the inner circle and the pressure by the outer square. Finally, when the state of a perfect gas is arrived at, the pressure would be represented by the outer square and the volume by the inner square, or the pressure is double the volume. The formula $\frac{21,000,000}{333 \times P} = V$. or $\frac{21,000,000}{333 \times V} = P$ is not, therefore, an accurate formula, for the quotient will require to be re-divided by a number increasing from 1 to 2. At boiling point the number is readily found, for it is the difference between the area of a circle and a square, $\frac{21,000,000}{333 \times 2116{\cdot}4 \times 1{\cdot}12838} = 26{\cdot}36$ volumes nearly.

I think the increase is best represented by supposing that at great temperatures there are no condensations in the vapour, which presses equally in all directions, but for each decreasing Centigrade degree of heat ·00366 in volume (or ·00203 for Fahrenheit) is condensed and knocked about by the other vapour like a ball, so that the space occupied gradually enlarges, and the pressure required decreases with the increasing momentum which it can give to the condensed atoms. The formula, therefore, will become $\frac{21{,}000{,}000}{333} \times \frac{1}{(768^\circ - \text{temp. Fahr.}) \times \cdot 00203 \times P \text{ or } V.}$ = V or P. This gives tolerably accurate results, and shows the way by which accurate results may be obtained hereafter without the use of the cumbrous and difficult formula which is now employed.

38. The distances of the larger planets are Jupiter 1·0, Saturn 1·83, Uranus 3·68, Neptune 5·75. Let the Sun be the centre of a circle of 27 units in diameter, representing the vapour of the series of the inner planets at its maximum density for 212°. Around this, Jupiter will circulate on the top of his own vapour at 203°, or the diameter of its orbit will be 31·26 + 27 + 31·26, with a radius = 44·7, which is the unit of distance. Saturn's distance will be 44·7 + 37·26 (or steam at 194°) = 1·83 of Jupiter's distance. Then begins the region of greatest cold, equal to Jupiter's distance, for it is caused by Jupiter's emission of vapour. Uranus then becomes hotter as the retrograde motion of his satellites shows; his volume will be the same as that of Saturn on both sides of his mass; Uranus's distance will therefore be 44·7 + 37·26 + (44·7 + 37·26) = 163·66 = 3·68 of Jupiter's distance, which is correct. Neptune is separated from the other planets by their three volumes = 37·26 + 31·26 + 27 —the heat surrounding it being the same as that of the Sun. Its distance will be therefore 44·7 + 37·26 + (44·7 + 37·26) + (37·26 + 31·26 + 27) = 259·18 = 5·75, or its correct distance from the Sun. If it should happen that the parts beyond Saturn are elevated somewhat, then the gradual decrease of heat to a certain distance and its increase from that point can be explained by supposing a double inclined plane, at the bottom of one end of which is the Sun, and Neptune at the other.

If the distance of the Earth is taken at ·64, Saturn = 9·53878 × ·64 = 6·10476; and this added to Jupiter's volume

31·58 = 37·684, which is nearly the volume of steam at 194°, or that upon which Saturn rolls round Jupiter. I merely bring this forward to suggest that there may be more simple reasons for the relative distances than that which I have assigned. I do not think that my view is improbable, for we know the pressure upon the Earth is that which requires a volume of 26·36 to sustain it, and there is no reason why the other spheres should not be sustained at much the same pressures; for why should we suppose the inhabitants of the Sun to be broiling hot, and Neptune and Uranus to be left shivering in the cold, when the whole space of the Universe lies open to equalise the different temperatures?

39. As the planets move in their orbits, openings are left for free communication with the Sun. Down these openings the various vapours of the planets condense and descend, and are driven back upon the earth as the seven great rays of light of different momenta. The Sun's atoms, whatever may be their density or velocity, must have the same momentum; but atoms met on the way have a negative velocity, and the overcoming of this before they can be driven forward produces the waves of different kinds of motion.

The inclination of the planets to the orbit of the Earth may be brought about by the cones at whose centres of gravity they are suspended, and which roll round the Sun's northern cone, being of different lengths. Thus if Mars's cone were 4 and the others 3, 2, 1 in length, Mars would be very little inclined to the ecliptic, and Mercury twice as much as Venus, which is much after the ratio of their known inclinations.

40. I have one more remark to make; it is about comets.

If you look at the helm of a ship as it is pulled from one side to another, it will be noticed that the drawing of the rudder to the right hand side (as one faces the stern) will produce a peculiar eddy, with motion in a direction the reverse of that which the planets take, the general body of the water coming forward. This, I think, will give an idea how comets are found going in a retrograde orbit. When the Sun sweeps round with its rotating winds it impels onwards the planets; but little bodies, such as the vapour surrounding it, are swept away back into space, till, beyond planetary influence, they can exude a little vapour in front of them to stop their progress, and so make themselves a little lighter than their neighbours. Saturn's ring seems to be the refuge of these little things, where they have density sufficient to refuse to follow the Sun's eddy, but not power to take an independent course. They are like corks floating in the lightest parts of the heavens. The tail of the comet does not, I should imagine, proceed out of the comet; it seems too enormous a velocity for even atoms to be hurled millions of miles in what may be called no time. I should prefer, therefore, to think that the tail of the comet is a condensation of matter proceeding to the Sun and opposed by the comet's body, the density being greater the nearer the Sun is approached.

The impacts which a body revolving receives from the Sun is equal to 570,000 miles per second in velocity, and I have no doubt the Sun receives the same in weight, if not velocity. Every thrust from the Sun condenses upon the colder surface of the comet, as the Earth's thrusts condense on the Moon, so that a nucleus is formed in front of it, and this nucleus will generally be more dense in the direction it is going from the resistance of the air in front of it as well. The comets proceed with such rapidity because the force they receive increases with the cube of the distance in two directions: they receive greater blows from the Sun as they approach it, and have greater weight pressing upon them from the planets, and this pressure is from cones which vary as the cube of their altitude. The time a comet takes over each mile will correspond with the diagonal of these two tangential striking forces, and so the square of the time will vary as the cube of the distance. The fall will not depend upon its size, but upon its condensing surface. It will fall towards the Sun until it obtains a state of internal heat, such as the Sun's vapour has at that distance; it will then be repelled always in the ratio of the Sun's heat, according to the momentum it will have received. Until the two bodies, the Sun and comet, have the same heat, the greater velocity of the Sun's impacts will only increase the comet's power of falling. The blows never touch the comet, but only the vapours surrounding it, and these will condense as fast as they are struck and fall upon, or be urged to the nucleus. Perhaps the reason they begin to approach the Sun is, that they are so very thin that they radiate heat faster than they receive it.

41. Whatever matter may be—whether it is simply condensed motion, as the diagonal of two forces, or something having a real existence—its only attribute is to press forward in all directions, unless it receives some special motion in one direction, and then it goes simply where it is sent, because that one motion overwhelms all the others. Real rest is impossible to matter. A line, if it has no extraordinary motion, will bulge outwards in the centre till it forms a double cone of denser material at its centre; these cones will again form other cones till a globe of solid materials is formed, played upon by two cones as small as may be imagined, but still acting like a hammer on a piece of metal on an anvil, and thrusting out other matter. The globe, again, will ever tend to expand; that is, matter will be forced from its centre to fill up a vacuum, or go where nothing presses it, till an equilibrium can be approached, which is never found. In God, not matter, is perfect rest.

The present generation is not inclined to look upon the attraction of gravity as an inherent quality of matter. I think I have, in an imperfect manner, accounted for the action of gravity in the Solar system, or at least shown how other persons may explain it. The diagonal of a parallelogram of forces is at the bottom of it all. By assuming the existence of vapour, or even pure motion, we can explain all Kepler's Laws. The vapour thrusts itself upon other vapour, and thus by degrees forms a mass of a conical form, because the momentum required becomes greater than the power of propulsion. The cone, then, in its pressure, presses with a force inversely as the square of the distance, for the cone is of that form that its condensations are proportional to twice the square of the diameter and the square of the altitude; and in the same plane the areas are in proportion to the areas of different circles, or the squares of their radii. The force also tends always to the centre of the Sun; for the Sun is the great source whence it proceeds, and the return pressure is, of course, in the same direction. And the absolute force is the same for all planets; for it is only one force, viz., the power of vapour of a certain density to support a certain weight. This vapour may, within itself, assume different densities; but as all the parts are connected together, and condensations are only possible in steam up to a certain extent in exact proportion to the force of the steam, there can only be but one force throughout the world. If the force were to become less, or the density too great, or if the opposite were to take place, equilibrium would immediately follow, either by condensation or expansion. The force must be that of 1 lb. sustaining 3 lbs., for it is the simple force of pressure, which may be said to require no heat to produce it, but can be made to produce boundless heat.

I have the honour to be, Sir,
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G. T. CARRUTHERS.
Chaplain, H.M.E.I.S. (on furlough).

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